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A checklist of the non-leaf-cutting fungus-growing ants (Hymenoptera, Formicidae) from Colombia, with new biogeographic records

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Abstract

The non-leaf-cutting fungus-growing ants deposited in two entomological collections in Colombia were curated and identified to assess their diversity in the country. We examined 680 specimens, identifying 41 species belonging to seven genera, bringing the total of fungus-growing ant species known from Colombia to 85. The following species are new records for Colombia: *Apterostigma angustum* Lattke, 1997, *Mycetomoellerius jamaicensis* (André, 1893), *Paratrachymyrmex diversus* (Mann, 1916), and *Paratrachymyrmex phaleratus* (Wheeler, 1925).

Keywords

Atta genus-group, Attini, biodiversity, fungus-farming ants, Neotropical ants.

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Introduction

The fungus-growing ants (tribe Attini, *Atta* genus-group, *sensu* Ward et al. 2015) are a monophyletic group endemic to the New World with the greatest diversity in the tropics, though some species may be found as far north as Long Island, New York, and as far south as Santa Cruz, Argentina (Gallardo 1915; Rabeling et al. 2007). Currently, fungus-growing ants consist of 245 valid species (Bolton 2020) in 19 genera (Li et al. 2018; Sosa-Calvo et al. 2018; Rabeling et al. 2019; Solomon et al. 2019). These ants live in an obligate mutualistic symbiosis with fungi from the Agaricaceae and Lepiotaceae families (Hölldobler and Wilson 2011). The fungus is the main food source for most colony members (Weber 1972; Hölldobler and Wilson 1990; Mehdiabadi and Schultz 2010) and founding queens must transport mycelium from the maternal fungus garden to the newly established nest to propagate the fungus garden (Febvay and Kermarrec 1981). This fungus cultivating behavior evolved once in ants, approximately 55–65 million years ago (Nygaard et al. 2016; Branstetter et al. 2017).

Based on phylogenetic correspondence among these ants, their cultivars, and other symbionts, attine fun-

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giculture is currently divided into five distinct systems (Schultz and Brady 2008; Mehdiabadi and Schultz 2010): (i) lower agriculture, which is presumably the ancestral condition among fungus-growing ants, as practiced by the so-called Lower attines, such as *Myrmicocrypta* Smith, 1860 and *Mycocepurus* Forel, 1893; (ii) coral-fungus agriculture, practiced by species in the *Apterostigma pilosum* species-group, the only ones cultivating fungi outside the tribe Leucocoprineae; (iii) yeast agriculture, practiced by species in the *Cyphomyrmex rimosus* species-group, which cultivate nodules of yeast-like cells in a unicellular phase.; (iv) generalized higher agriculture, practiced by the non-leaf-cutting genera *Mycetomoellerius* Solomon *et al.*, 2019, *Paratrachymyrmex* Solomon *et al.*, 2019, *Sericomyrmex* Mayr, 1865, *Trachymyrmex* Forel, 1893, and *Xerolitor* Sosa-Calvo *et al.*, 2018; and (v) leaf-cutting agriculture, considered a derived form of higher agriculture, practiced by species of the leaf-cutting ant genera *Atta* Fabricius, 1804 and *Acromyrmex* Mayr, 1865.

The fascinating biology of this ant-fungus-microbe symbiosis has driven researchers to study the biology and taxonomy of attine ants in Colombia for decades (Fernández and Sendoya 2004; Vergara-Navarro and Serna 2013; Fernández and Serna 2019). Parallel to this increasing research interest, the recorded number of species has also increased in recent years. Fernández and Sendoya (2004) listed at least 20 species of non-leaf-cutting fungus-farming ants in Colombia. Vergara-Navarro and Serna (2013) recorded eleven more species of non-leaf-cutting fungus-farming ants from the central region of the country. Recently, Fernández et al. (2015) revised the 12 leaf-cutting ant species of Colombia, and in a recently published book on the ants of Colombia, Fernández and Serna (2019) recognize a total of 76 fungus-growing ant species.

This study provides a taxonomic update of the species of non-leaf-cutting fungus-growing ants known in Colombia, by examining the specimens in two entomological collections of the Universidad Nacional de Colombia: (i) the Museo Entomológico "Universidad Nacional Agronomía Bogotá" (UNAB), located at the Agricultural Sciences Department in Bogotá, and (ii) the Museo Entomológico "Francisco Luis Gallego" (MEFLG) located at the Sciences Department in Medellín. The UNAB collection was established in 2001 and contains more than 200,000 specimens representing 20 orders of Hexapoda (Martinez-Alava and Serna 2015; Serna et al. 2017). The Museo Entomológico "Francisco Luis Gallego" was established in 1937 and houses around 350,000 insect specimens (Serna et al. 2017). We examined a total of 680 specimens, recognizing 41 non-leaf-cutting fungus-growing ant species in Colombia, including four new records and five potentially new species.

Methods

Ant specimens were curated following the protocol in Martínez-Alava and Serna (2015). Alcohol-preserved specimens were individually point-mounted, labelled with the corresponding collecting data, and placed into Ward boxes. Each box was then tagged with the species name, and a unique identifier catalog number per taxon.

Morphological terminology follows Serna and Mackay (2010), Serna et al. (2011), Lattke (1997), and Delsinne et al. (2019). Specimens were identified to genus level employing the taxonomic studies of Serna and Vergara-Navarro (2001), Fernández and Serna (2019) and Solomon *et al.* (2019). Species identification was achieved using published and unpublished taxonomic keys for *Apterostigma* Mayr, 1865 (Lattke 1997); *Cyphomyrmex* Mayr, 1862 (Kempf 1967; Snelling and Longino 1992; Sanhudo 2011; Albuquerque 2014); *Mycocepurus* (Kempf 1963; Mackay et al. 2004); *Myrmicocrypta* (Sosa-Calvo 2015); *Sericomyrmex* (Ješovnik and Schultz 2017); *Paratrachymyrmex* and *Mycetomoellerius* (Mayhé-Nunes and Brandão 2002, 2005, 2007; Rabeling et al. 2007; Solomon et al. 2019). Specimens were studied with a Leica M205 C stereomicroscope and were compared with specimens deposited in the Social Insects Biodiversity Repository at Arizona State University in Tempe, AZ, U.S.A. (ASU-SIBR) and to images available on Antweb database (https://www.antweb.org). Most of the images used to illustrate species in this study (Figs 2–10) were obtained from Antweb with permission, and the photographer and specimen codes are specified in each figure caption. All other composite images were generated using a Leica DFC450 digital camera, mounted onto a Leica M205 C stereomicroscope and stacked with either the Leica Application Suite (Version 4.5) or the Helicon Focus (Version 6.6.1) software packages. Species distribution maps were created with QGIS Version 3.14.0 software (QGIS 2020).

Results

We studied 680 fungus-growing ant specimens representing 41 species in seven genera: *Apterostigma* (18 species), *Cyphomyrmex* (8 spp.), *Mycetomoellerius* (3 spp.), *Mycocepurus* (1 sp.), *Myrmicocrypta* (2 spp.), *Paratrachymyrmex* (5 spp.), and *Sericomyrmex* (4 spp.). Four species are new records for Colombia: *Apterostigma angustum* Lattke, 1997, *Mycetomoellerius jamaicensis* (André, 1893), *Paratrachymyrmex diversus* (Mann, 1916), and *Paratrachymyrmex phaleratus* (Wheeler, 1925).

We also identified five species that are potentially new to science, three in *Apterostigma*, one in *Myrmicocrypta,* and one in *Mycetomoellerius.* These species will eventually be described in ongoing revisionary studies of the respective genera.

Departments surveyed. We recorded non-leaf-cutting fungus-farming ants in 38 municipalities from 17 departments (Fig. 1A–D): Amazonas, Antioquia, Atlántico,

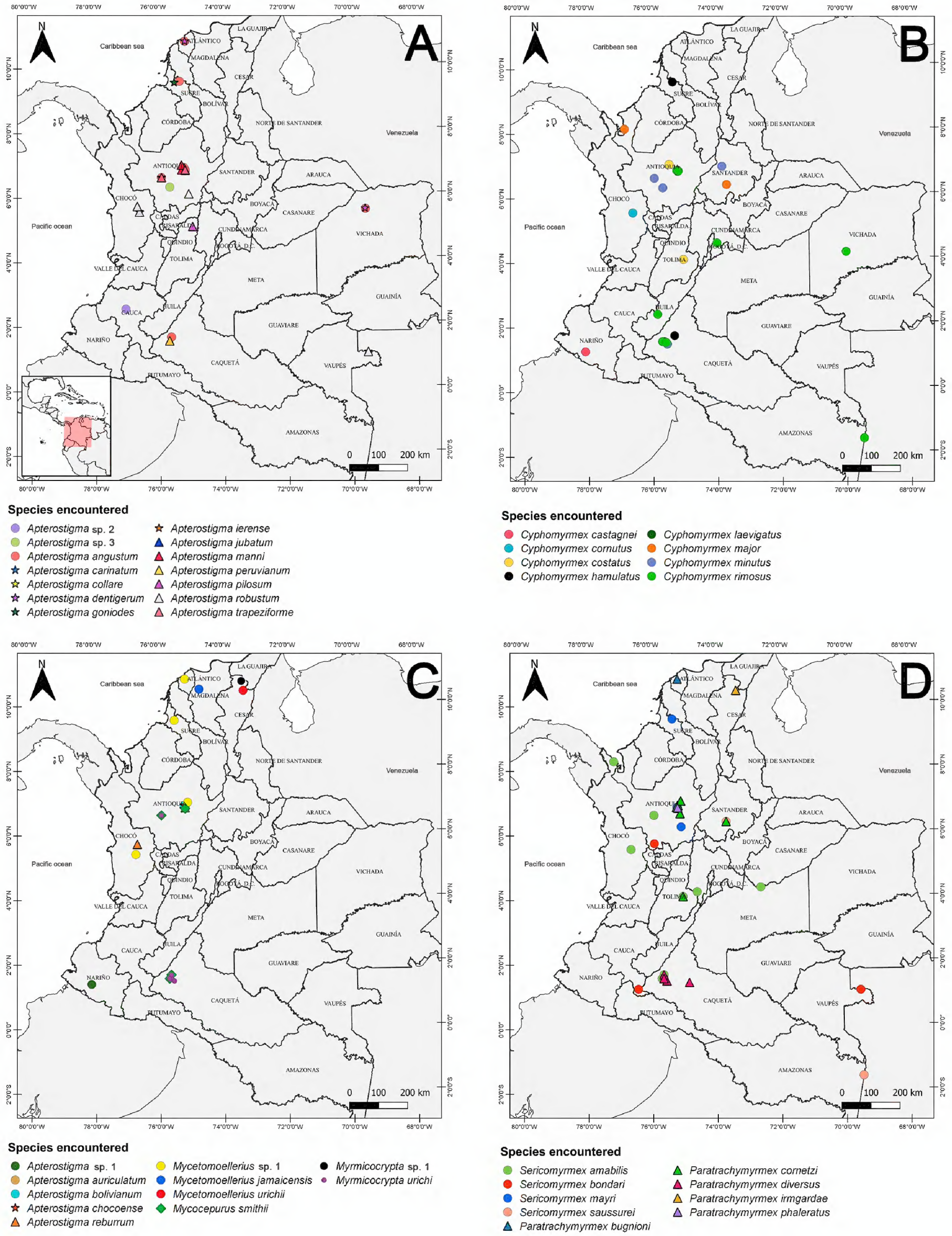

Figure 1. Geographic distribution of non-leaf-cutting fungus-growing ant species in Colombia. **A**. *Apterostigma pilosum* species-group. **B.** Genus *Cyphomyrmex*. **C.** *Apterostigma auriculatum* species-group, and genera *Mycocepurus*, *Myrmicocrypta*, and *Mycetomoellerius*. **D.** Genera *Sericomyrmex* and *Paratrachymyrmex*.

Caquetá, Cauca, Cesar, Chocó, Cundinamarca, Guaviare, Huila, Meta, Nariño, Putumayo, Santander, Sucre, Tolima, and Vaupés. *Sericomyrmex amabilis* Wheeler, 1925 is the most widely distributed species in the country, being present in six departments.

Elevational distribution. Specimens were collected in localities ranging from sea level up to 1927 m, with an average of 572 m, though most of the species (90%) were found in locations below 650 m. However, some species such as *Cyphomyrmex major* Forel, 1901, *Cypho-*

myrmex rimosus (Spinola, 1851), and *Sericomyrmex bondari* Borgmeier, 1937 show an extended altitudinal distribution: 1–1426 m, 280 –1927 m, and 85–1700 m, respectively.

Examined material.

Apterostigma Mayr, 1865

(1) *Apterostigma angustum* Lattke, 1997
Figure 2A, B

Material examined. COLOMBIA: **Antioquia** • 4 workers; Amalfi; 06°46′66″N, 075°06′42″W; alt. 1045 m; 25 Jun. 1997; F. Serna leg.; UNAB 4365; **Antioquia** • 6 workers; Amalfi; 06°51′26″N, 075°07′32″W; alt. 1000 m; 30 Jul. 1997; F. Serna leg.; MEFLG 5786; **Antioquia** • 2 workers; Amalfi; 06°45′42.43″N, 075°05′28.31″W; alt. 1221 m; Sep. 2006; M. A. Vanegas leg.; MEFLG 11086; **Antioquia** • 2 workers; Santafé de Antioquia; 06° 33′41″N, 075°49′54″W; alt. 600 m; 06 Oct. 2000; E. Vergara, F. Serna leg.; UNAB 4738; **Antioquia** • 12 gynes, 20 workers; Amalfi; 06°51′26″N, 075°07′32″W; alt. 1000 m; 30 Jul. 1997; F. Serna leg.; MEFLG 5786; **Atlántico** • 1 worker; Juan de Acosta; 10°46′02″N, 075° 02′34″W; alt. 117–250 m; Feb.–May 2012; J. Castro, S. Royero leg.; UNAB 5457; **Caquetá** • 8 workers; Florencia; 01°37′11″N, 075°36′14″W; alt. 300 m; 31 Mar. 2016; F. Serna leg.; UNAB 4365; **Chocó** • 1 worker; Lloró; 05° 29′00″N, 076°32′00″W; alt. 115 m; 04 Mar. 2001; J. Neita leg.; UNAB 4366; **Chocó** • 4 workers; Lloró; 05°29′00″N, 076°32′00″W; alt. 115 m; 03 Nov. 2000; J. Neita leg.; UNAB 4366; **Sucre** • 1 worker; Ovejas; 09°32′4.1″N, 075° 13′18.5″W; alt. 277 m; 4 Feb. 2016; H. Cadena leg.; MEFLG 40895.

Identification. Frontal lobes in frontal view triangular; general cephalic profile in lateral view ovoid; compound eyes relatively small; and ventral mesopleural carina (epicnemial carina of Serna and Mackay 2010) absent (Lattke 1997).

Distribution. The specimens found in Colombia are all new records for the country as well as a major range expansion to the west (Fig. 1A) as *Apterostigma angustum* was only known from Venezuela and French Guiana (Lattke 1997; Fernández and Sendoya 2004).

(2) *Apterostigma auriculatum* Wheeler, 1925
Figure 2C, D

Material examined. COLOMBIA: **Antioquia** • 1 worker; Amalfi; 06°54′11″N, 075°05′26.7″W; alt. 1045 m; 20 Apr. 1998; F. Serna leg.; UNAB 4361.

Identification. Eyes relatively big and prominent (more than nine ommatidia along the shortest axis); frontal lobes subquadrate in full-face view, anterior margin of clypeus concave, lacking shiny cuticular strip; neck relatively long and broad, lacking median carina; humeral prominence in dorsal view shaped as angular lobe; ventral mesopleural carina in lateral view fine; and petiole in lateral view triangular, with antero- and posterodorsal profiles almost of same length (Lattke 1997).

Distribution. This species occurs from Honduras to Mato Grosso do Sul in Brazil and is widely distributed throughout central and northwestern South America (Lattke 1997; Fernández and Sendoya 2004).

(3) *Apterostigma bolivianum* Weber, 1938
Figure 2E, F

Material examined. COLOMBIA: **Antioquia** • 1 worker; Amalfi; 06°51′26″N, 075°07′32″W; alt. 1000 m; 30 Jul. 1997; F. Serna leg.; MEFLG 40854.

Identification. Eyes prominent (more than nine ommatidia along the shortest axis); frontal lobes in full-face view subquadrate; anterior margin of clypeus in full-face view concave, lacking shiny cuticular strip; neck lacking median carina; mandibles elongate; anterior margin of pronotum in dorsal view convex, with median emargination and no lateral thickening; and mesopleural ventral carina in lateral view well-developed, thick (Lattke 1997).

Distribution. In Colombia, *A. bolivianum* was only known from Amazonas, thus the new record from Antioquia (Fig. 1C) suggests this species might be broadly distributed throughout the country (Fig. 1C) (Weber 1938; Kempf 1972; Fernández et al. 1996; Lattke 1997). *Apterostigma bolivianum* is also known from the following countries in northwestern South America: Bolivia, Ecuador, Peru, and Venezuela.

(4) *Apterostigma carinatum* Lattke, 1997
Figure 2G, H

Material examined. COLOMBIA: **Chocó** • 1 worker; Lloró; 05°30′39″N, 76°32′40″W; alt. 115 m; 12 Dec. 2001; Y. Palacios, O. Mena leg.; UNAB 5458; **Chocó** • 1 worker; Lloró; 05°30′00″N, 076°31′00″W; alt. 97 m; 18 Nov. 2002; O. Mena, Y. Palacios leg.; UNAB 5458; **Vaupés** • 1 worker; Taraira; 01°04′00″S, 069°31′00″W; alt. 85 m; 4–20 May 2001; A. Sabogal leg.; UNAB 5458.

Identification. Frontal lobe in full-face view either convex or triangular, with rounded apex; anterior margin of clypeus in full-face view convex, with shiny cuticular strip; dorsal mesosomal carina present, in lateral view low and uniform; petiole in lateral view elongate; dorsal and ventral curvatures of gaster in lateral view similar in size; lateral carina of gaster inconspicuous; and metacoxa with dorsoposterior keel (Lattke 1997).

Distribution. This species is known to occur in Ecuador and the Pacific coast of Colombia. The present record from Vaupés expands its geographic distribution to the Amazonian region of the country (Fig. 1A) (Lattke 1997; Solar et al. 2016).

(5) *Apterostigma chocoense* Lattke, 1997
Figure 3A, B

Material examined. COLOMBIA: **Antioquia** • 9 work-

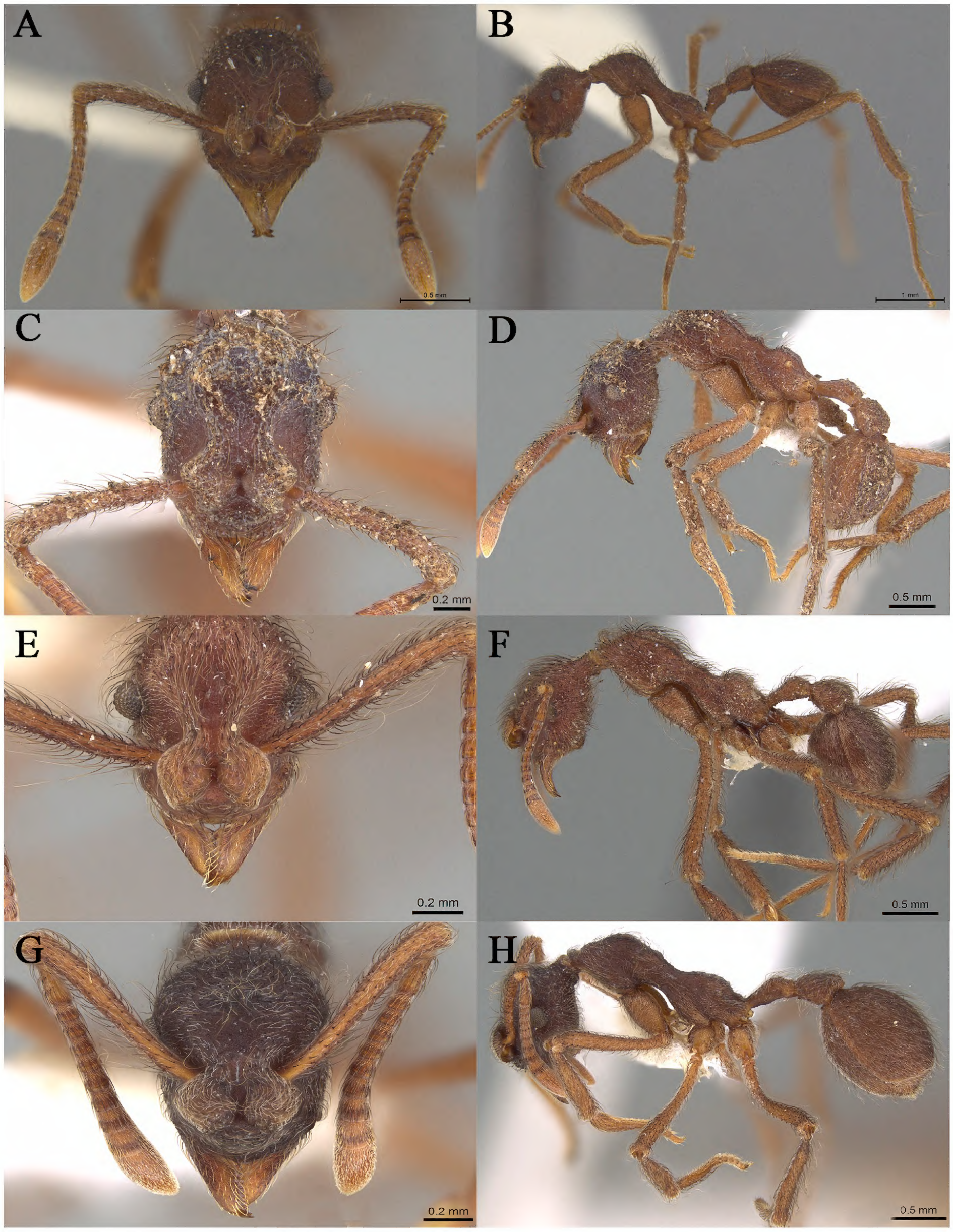

Figure 2. *Apterostigma* species encountered in Colombia. **A, B.** *Apterostigma angustum*, J. Sosa-Calvo. **C–H.** Figures taken by M. Esposito obtained from the Antweb database (http://www.antweb.org). **C, D.** *Apterostigma auriculatum*, CASENT0922035. **E, F.** *Apterostigma bolivianum*, CASENT0922036. **G, H.** *Apterostigma carinatum*, CASENT0922038.

ers; Amalfi; 06°51′26″N, 075°07′32″W; alt. 1000 m; 30 Jul. 1997; F. Serna leg.; MEFLG 40855, 40856, 40857.

Identification. Triangular propodeal denticles present; ventral profile of gaster convex anteriorly and concave posteriorly; and ventral profile of gaster in lateral view sinuous (Lattke 1997).

Distribution. The present record expands the species known distribution in Colombia from the northwestern

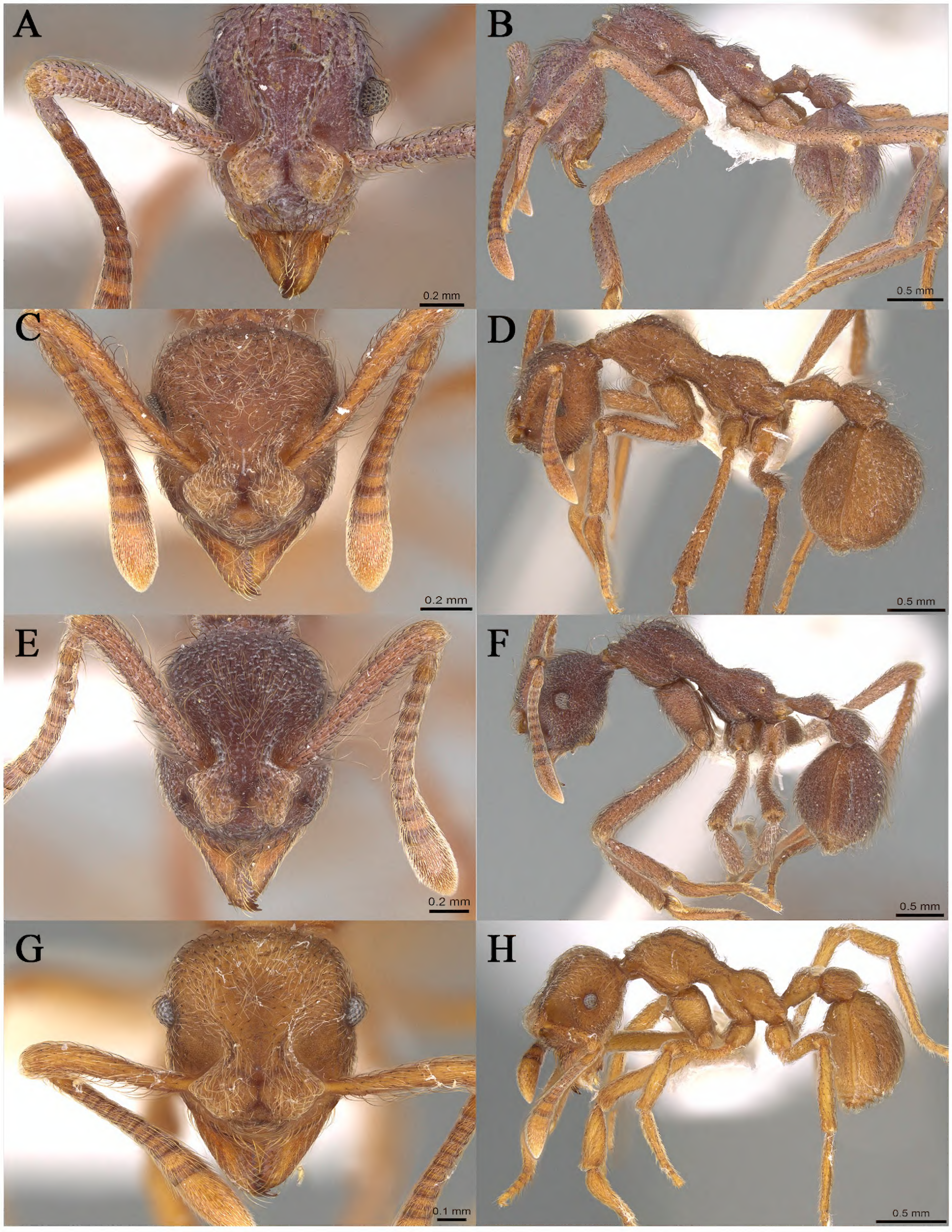

Figure 3. *Apterostigma* species encountered in Colombia. **A, B.** *Apterostigma chocoense*, CASENT0922037. **C, D.** *Apterostigma collare*, CASENT0922041. **E, F.** *Apterostigma dentigerum*, CASENT0922039. **G, H.** *Apterostigma goniodes*, CASENT0922040. Photographs taken by M. Esposito obtained from the Antweb database (http://www.antweb.org).

Pacific coast to the Andean region (Fig. 1C). Outside of Colombia this species is known in Costa Rica, French Guiana, and Panama (Brandão 1991; Lattke 1997; Fernández and Sendoya 2004).

(6) *Apterostigma collare* Emery, 1896

Figure 3C, D

Material examined. COLOMBIA: **Chocó** • 1 worker; Lloró; 05°29′00″N, 076°32′00″W; alt. 115 m; 15 Mar.

2002; Y. Palacios, O. Mena leg.; UNAB 4739.

Identification. Frontal lobes in frontal view subquadrate, with lateroventral margin curved posteriorly; anterior clypeal margin with a median angle; gaster in lateral view subspherical, with inconspicuous lateral carina; and body lacking erect hairs (Lattke 1997).

Distribution. Previous Colombian records are from the departments of Cauca, Valle del Cauca, and Magdalena. This new record from Chocó indicates the species might be widely distributed across the Pacific and northern coasts of the country (Fig. 1A). *Apterostigma collare* is known from several countries in Central America: Costa Rica, Honduras, Mexico (Veracruz), Nicaragua, and Panama. In South America it has been found only in Colombia and Venezuela (Lattke 1997).

(7) *Apterostigma dentigerum* Wheeler, 1925
Figure 3E, F

Material examined. COLOMBIA: **Atlántico** • 1 worker; Juan de Acosta; 10°46′2″N, 075°02′34″W; alt. 177–250 m; Feb.–May 2012; J. Castro, S. Royero leg.; UNAB 4362; **Chocó** • 2 workers; Lloró; 05°29′00″N, 076° 32′00″W; alt. 115 m; 12 Dec. 2001; Y. Palacios, O. Mena leg.; UNAB 4740; **Chocó** • 1 worker; Lloró; 05°29′00″N, 076°32′00″W; alt. 115 m; 04 May 2002; Y. Palacios, O. Mena leg.; UNAB 2230.

Identification. Frontal lobes in frontal view with strong angle or posterolateral lobe; lateral-ventral margin of frontal lobe sinusoidal: convex posteriorly and curved towards dorsum, without any ventral curvature; and propodeum in lateral view with anterodorsal profile long and gradually very convex, posteriorly shorter and more curved (Lattke 1997).

Distribution. *Apterostigma dentigerum* is widely distributed in Central and South America, its known distribution range extends from Honduras to Mato Grosso in central Brazil (Lattke 1997; Mayhé-Nuñes and Jaffé 1998).

(8) *Apterostigma goniodes* Lattke, 1997
Figure 3G, H

Material examined. COLOMBIA: **Antioquia** • 5 workers; Santafé de Antioquia; 06°33′41″N, 075°49′54″W; alt. 600 m; 06 Oct. 2000; E. Vergara, F. Serna leg.; UNAB 4772; **Antioquia** • 2 workers; Santafé de Antioquia; 06° 33′41″N, 075°49′54″W; alt. 600 m; 06 Oct. 2000; E. Vergara, F. Serna leg.; UNAB 4772; **Sucre** • 1 worker; Colosó; 09°29′44″N, 075°23′17″W; alt. 200–700 m; 30 Aug. 2009; G. Mercado leg.; UNAB 4741; **Sucre** • 2 workers; Colosó; 09°29′44″N, 075°23′17″W; alt. 200–700 m; 29 Aug. 2009; G. Mercado leg.; UNAB 4741.

Identification. Frontal lobes in frontal view triangular, each posterior margin forms an (almost) right angle with the lateral margin; ventral mesopleural carina well-developed and lamelliform; and longitudinal translucent keel present on the postpetiolar sternite (Lattke 1997).

Distribution. *Apterostigma goniodes* is distributed from southern Mexico throughout Central America to Colombia (Lattke 1997; Castro et al. 2018; García-Cárdenas et al. 2018).

(9) *Apterostigma ierense* Weber, 1937
Figure 4A, B

Material examined. COLOMBIA: **Vaupés** • 1 worker; Taraira; 01°04′00″S, 069°31′00″W; alt. 85 m; 14–20 May 2001; A. Sabogal leg.; UNAB 4742.

Identification. Lateroventral margin of frontal lobes completely curved and covering the antennae insertions; the cervical carina in dorsal view is shaped as two rounded lobes; and body densely pubescent (Lattke 1997).

Distribution. *Apterostigma ierense* is mostly distributed in the Amazon basin, being reported from Bolivia, Brazil, Colombia, Ecuador, Peru, and Venezuela. In Central America, *A. ierense* is only known from Panama (Kempf 1972; Lattke 1997; Mayhé-Nuñes and Jaffé 1998; Fernández and Sendoya 2004).

(10) *Apterostigma jubatum* Wheeler, 1925
Figure 4C, D

Material examined. COLOMBIA: **Chocó** • 1 worker; Quibdó; 05°40′40″N, 076°35′36″W; alt. 35 m; 24 Nov. 2001; J. Neita leg.; UNAB 4743.

Identification. Head in frontal view with frontal lobes ovoid; anterior portion of clypeus with profile concave and convex in the middle; mandibles with 7–8 teeth; and humeral prominence high (Lattke 1997).

Distribution. *Apterostigma jubatum* is mostly distributed throughout the Amazon-Orinoco basin, known to occur in Bolivia, Colombia, Peru, and Venezuela (Fernández et al. 1996; Lattke 1997) as well as the Brazilian states of Amazonas, Minas Gerais, and Pará.

(11) *Apterostigma manni* Weber, 1938
Figure 4E, F

Material examined. COLOMBIA: **Antioquia** • 2 workers; Amalfi; 06°55′00″N, 075°04′00″W; alt. 990 m; 30 Jul. 1997; F. Serna leg.; UNAB 4745; MEFLG 5787; **Antioquia** • 1 worker; Santafé de Antioquia; 06°33′41″N, 075°49′54″W; alt. 600 m; 06 Oct. 2000; E. Vergara, F. Serna leg.; UNAB 4744; **Caquetá** • 1 worker; Florencia; 01°30′4″N, 075°39′42″W; alt. 280 m; 01 Sep. 2017; UNAB members leg.; UNAB 4745.

Identification. Eyes reniform; mesopleural carina well-developed and lamelliform; postpetiole usually with ventral lamelliform longitudinal carina; body yellowish or light brown; and abdominal sternite IV with antero-median transverse carina (Lattke 1997).

Distribution. *Apterostigma manni* is present in southern Central America (Costa Rica and Panama), northwestern South America (Bolivia, Colombia, Peru, and Venezuela), and in the Brazilian states of Bahia and Minas Gerais (Lattke 1997; Fernández and Sendoya 2004).

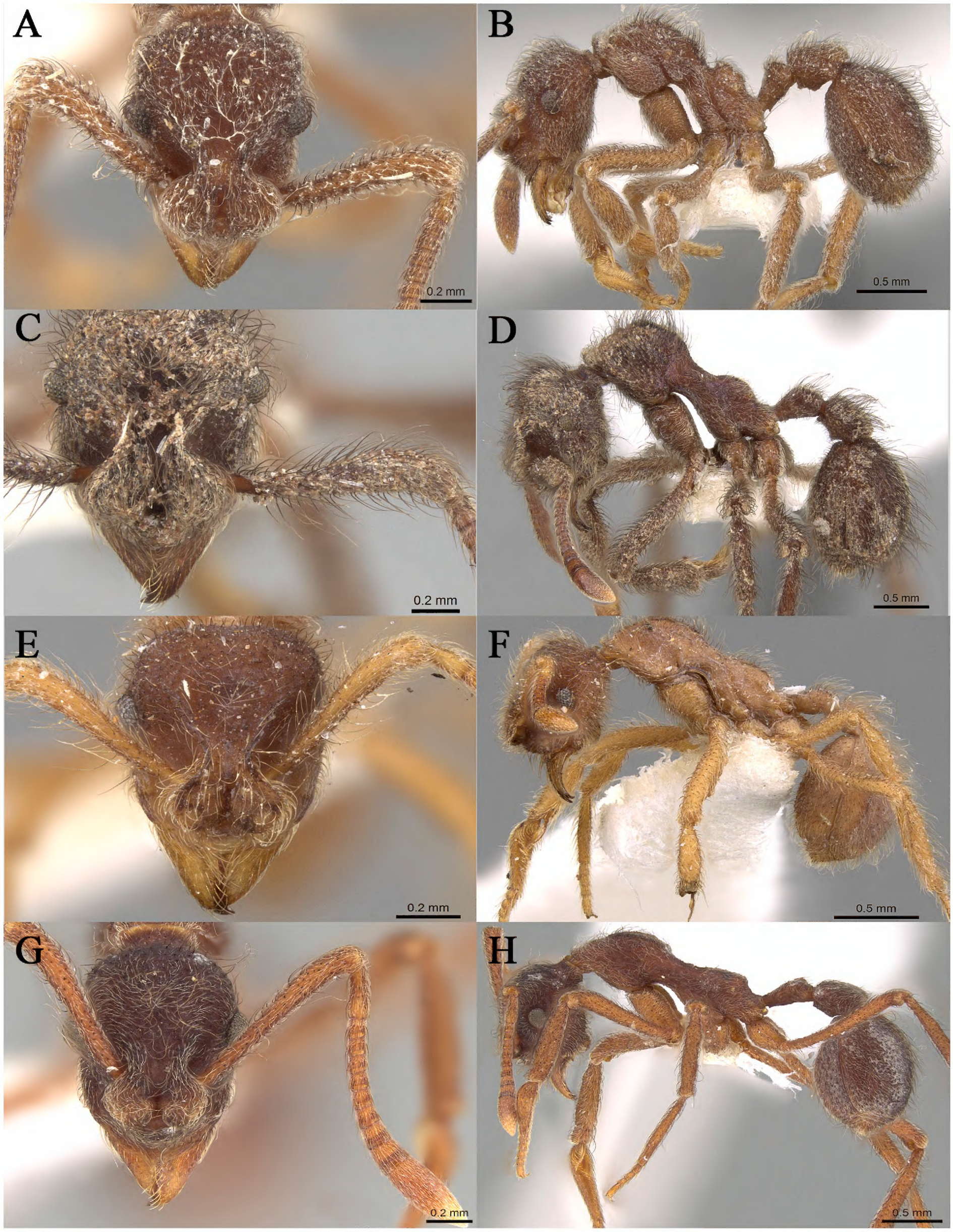

Figure 4. *Apterostigma* species encountered in Colombia. **A, B.** *Apterostigma ierense*, CASENT0281772. **C, D.** *Apterostigma jubatum*, CASENT0281773. **E, F.** *Apterostigma manni*, CASENT0281776. **G, H.** *Apterostigma peruvianum*, CASENT0922046. Photographs taken by S. Hartman (**A–F**) and M. Esposito (**G–H**) obtained from the Antweb database (http://www.antweb.org).

(12) *Apterostigma peruvianum* Wheeler, 1925
Figure 4G, H

Material examined. COLOMBIA: **Caquetá** • 3 workers; Florencia; 01°30′4″N, 075°39′42″W; alt. 280 m; Sep. 2017; UNAB members leg.; UNAB 4737.

Identification. Frontal lobes in frontal view subquadrate, each posterior margin straight and inclined, anterolateral margins convex; posterior cephalic profile rounded; eyes

with a maximum of 10 ommatidia along the shortest axis; and postpetiole with posteroventral process relatively big and usually dentiform (Lattke 1997).

Distribution. Previous Colombian records are from Valle del Cauca, thus this new record from Caquetá expands the distribution of this species from the Andes into the Amazon region (Fig. 1A). Besides Colombia, *Apterostigma peruvianum* is also present in Bolivia, Ecuador, Peru, and Venezuela (Kempf 1972; Lattke 1997; Fernández and Sendoya 2004).

(13) *Apterostigma reburrum* Lattke, 1997
Figure 5A, B

Material examined. COLOMBIA: **Antioquia** • 1 worker; Amalfi; 06°55′00″N, 075°04′00″W; alt. 1045 m; 20 Apr. 1998; F. Serna leg.; UNAB 5454; **Chocó** • 1 worker; 05°40′40″N, 076°35′36″W; alt. 35 m; 24 Nov. 2001; J. Neita leg.; UNAB 5454.

Identification. Subocular prominence higher than eye in frontal view of head; anteroventral petiolar denticle well-developed; body with abundant semi-erect thick hairs; propodeum without denticles; and cephalic neck short and lacking carina (Lattke 1997).

Distribution. Besides the Colombian departments of Antioquia, Valle del Cauca, and San Andres Island, *A. reburrum* is only known from French Guiana (Lattke 1997; Fichaux et al. 2019), but this disjunct distribution suggests the species might be more widely distributed across northern South America and possibly the Caribbean.

(14) *Apterostigma robustum* Emery, 1896
Figure 5C, D

Material examined COLOMBIA: **Antioquia** • 1 worker; San Luis; 06°02′33.7″N, 074°59′39.9″W; alt. 1005 m; Mar. 1992; F. Serna leg.; MEFLG 5170; **Chocó** • 4 workers; Quibdó; 05°40′40″N, 076°35′36″W; alt. 35 m; 23 Nov. 2001; J. Neita leg.; UNAB 4747; **Vaupés** • 3 gynes, 6 workers; Taraira; 01°04′00″S, 069°31′00″W; alt. 85 m; 14–20 May 2001, A. Sabogal leg.; UNAB 4746.

Identification. Frontal lobes with each lateral margin convex and strongly curved ventrally; anterior margin of clypeus uniformly convex; mandible with 11 teeth that increase gradually in size towards the apical tooth; and propodeum in lateral view gradually higher than the metanotum (Lattke 1997).

Distribution. *Apterostigma robustum* is distributed from Honduras in Central America south to Bolivia and Brazil, where it occurs in the states of Amazonas, Maranhão, and Pará (Kempf 1972; Lattke 1997; Fernández and Sendoya 2004).

(15) *Apterostigma pilosum* species complex
Figure 5E, F

Material examined. COLOMBIA: **Antioquia** • 5 workers; Amalfi; 06°55′00″N, 075°04′00″W; alt. 1045 m; 25 Jun. 1997; F. Serna leg.; UNAB 5453; **Antioquia** • 2 workers; Amalfi; 06°46′39″N, 075°05′22″W; alt. 1550 m; 30 Jul. 1997; F. Serna leg.; MEFLG 40843; **Antioquia** • 1 worker; Santafé de Antioquia; 06°33′41″N, 075°49′45″W; alt. 600 m; 06 Oct. 2000; E. Vergara, F. Serna leg.; UNAB 5453; **Tolima** • 1 worker; Armero; 05°01′55″N, 074°53′27″W; alt. 261 m; 12 Apr. 2012; G. Villamizar leg.; UNAB 5453.

Identification. The *Apterostigma pilosum* species-complex needs a thorough taxonomic revision. Lattke (1997) provides a general diagnosis for the putative species in the complex: eyes with 5–6 ommatidia along the minor axis; mesopleural ventral carina present or absent but never prominent, lamelliform, nor thick and shining; frontal lobes in cephalic dorsal view triangular or uniformly convex; anterolateral mesonotal prominence absent; and dorsal postpetiolar profile in lateral view strongly curved. The above specimens all agree with this diagnosis.

Distribution. The species of the *Apterostigma pilosum* complex are widely distributed in Central and South America, ranging from Tamaulipas in Mexico south to Buenos Aires, Argentina.

(16) *Apterostigma* sp. 1, *auriculatum* species-group

Material examined. COLOMBIA: **Nariño** • 1 worker; Barbacoas; 01°21′49″N, 078°04′45″W; alt. 640 m; 25–29 Jul. 2006; A. Miranda leg.; UNAB 5459.

Comment. This presumably new species is only known from a single worker and will be described in a forthcoming taxonomic revision of the *A. auriculatum* species-group.

(17) *Apterostigma* sp. 2, *pilosum* species-group

Material examined. COLOMBIA: **Cauca** • 1 worker; Tambo; 02°30′24.11″N, 076°59′57″W; alt. 1448 m; 1–8 Apr. 2006; A. Galvis, Y. Mena leg.; UNAB 5455.

Comment. This new *Apterostigma* species is only known from a single worker and will be described in a forthcoming taxonomic study.

(18) *Apterostigma* sp. 3, *pilosum* species-group

Material examined. COLOMBIA: **Antioquia** • 1 worker; Medellín; 06°15′44.4″N, 075°34′33.4″W; alt. 1460 m; May 1999; MEFLG members leg.; MEFLG 5786.

Comment. This new *Apterostigma* species is only known from a single worker and will be described in a forthcoming taxonomic treatment.

Cyphomyrmex Mayr, 1862

(19) *Cyphomyrmex castagnei* Mackay & Baena, 1993

Material examined. COLOMBIA: **Nariño** • 1 worker; Ricaurte; 01°13′35″N, 078°03′04″W; alt. 920 m; 21 Sep. 2015; J. Cancino leg.; UNAB 4748.

Identification. Mandible with five teeth; lateral corner of cephalic vertex with long horn-like extensions;

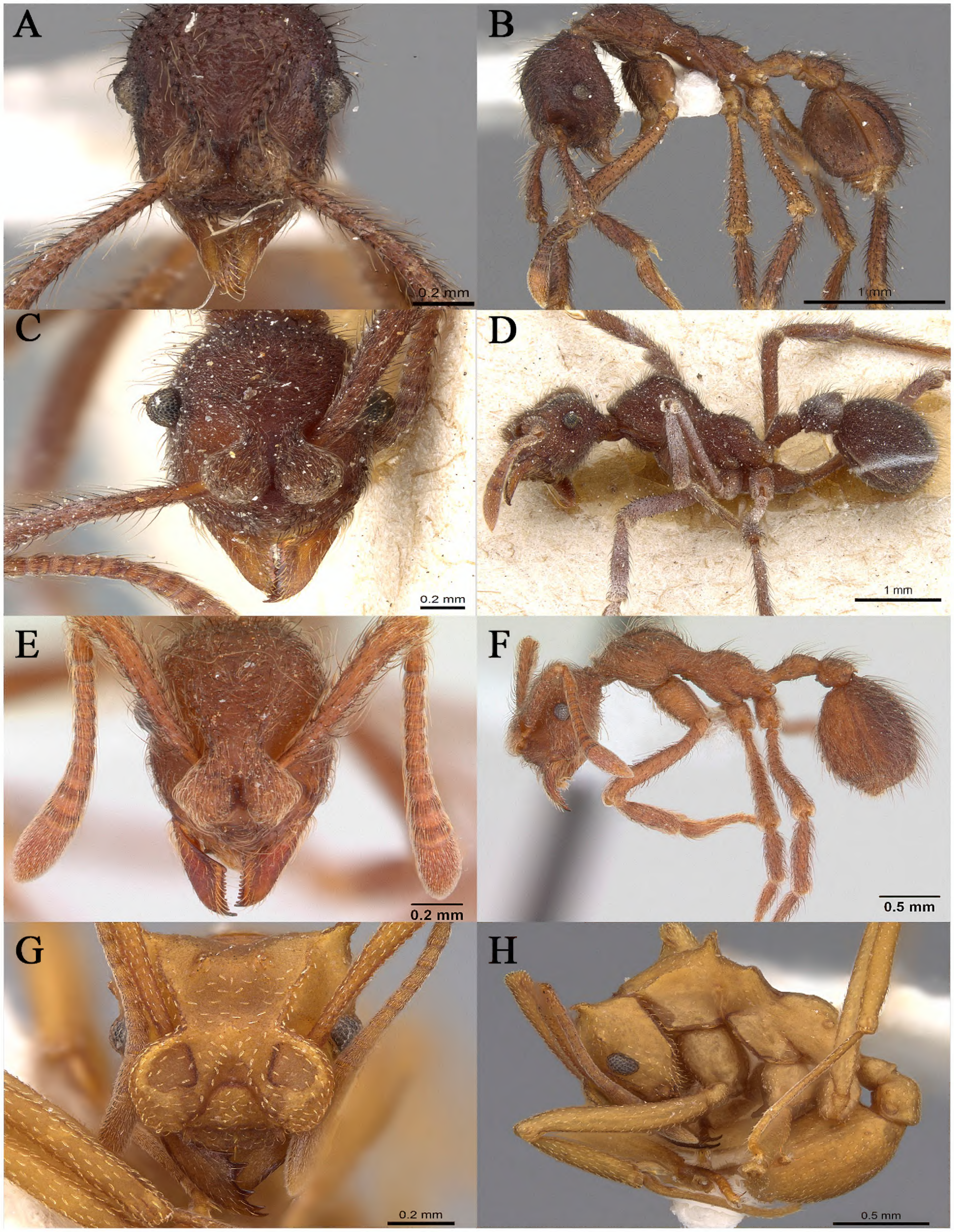

Figure 5. *Apterostigma* and *Cyphomyrmex* species encountered in Colombia. **A, B.** *Apterostigma reburrum*, CASENT0901686/ R. Perry. **C, D.** *Apterostigma robustum*, CASENT0904977/ Z. Lieberman. **E, F.** *Apterostigma pilosum* complex, CASENT0603533/ A. Nobile. **G, H.** *Cyphomyrmex cornutus*, CASENT0923103/ W. Lee. Photographs obtained from the Antweb database (http://www.antweb.org).

mesosoma with a large, spine-like posterior pronotal tubercle and a large anterior mesonotal tubercle; mesonotal protuberances spine like; and mesosoma with squamate hairs (Mackay and Baena 1993).

Distribution. *Cyphomyrmex castagnei* is only known from Panama and the Pacific coast of Colombia (Fig. 1B) (MacKay and Baena 1993; Fernández et al. 1996; Fernández and Sendoya 2004).

(20) *Cyphomyrmex cornutus* Kempf, 1968
Figure 5G, H

Material examined. COLOMBIA: **Chocó** • 7 workers; Lloró; 05°30′00″N, 076°31′00″W; alt. 90 m; 25 Oct. 2000; J. Neita leg.; UNAB 545, MEFLG 6936.

Identification. Cephalic and mesonotal protuberances horn-like; preocular carina curves above eye; frontal lobes broadly expanded, semicircular; pronotum without median paired denticles, humeral prominence weakly developed and postero-lateral tubercle more developed, antero-ventral corner rectangular; and mesonotum with anterior pair of very prominent spines and posterior pair of very low denticles (Kempf 1968).

Distribution. *Cyphomyrmex cornutus* is widely distributed in Central and South America. It has been recorded from Veracruz state in Mexico, south to Costa Rica, Colombia, Ecuador, French Guiana, and the Brazilian states of Acre and Bahia. This ample and somewhat disjunct distribution suggests that *C. cornutus* might have a continuous distribution throughout Central America and northern South America (Adams and Longino 2007; Miranda et al. 2012; Vergara-Navarro and Serna 2013; Santos et al. 2017).

(21) *Cyphomyrmex costatus* Mann, 1922
Figure 6A, B

Material examined. COLOMBIA: **Antioquia** • 4 gynes; Amalfi; 06°59′01″N, 075°22′06″W; alt. 975 m; 30 Jul. 1997; F. Serna leg.; MEFLG 40837; UNAB 553, 3461, 4749; **Tolima** • 2 workers; Guamo; 04°02′05″N, 074°58′25″W; alt. 323 m; 19 Aug. 2003; F. Serna, E. Díaz leg.; UNAB 4749, 3461.

Identification. Disc of first gastral tergum with strong longitudinal ridges on each side of midline; mid-pronotal tubercles absent; and posterodorsal margin of petiole neither drawn out nor bidentate (Kempf 1965).

Distribution. *Cyphomyrmex costatus* is continuously distributed throughout Central and northern South America, from the states of Oaxaca and Veracruz in Mexico, to the states of Amazonas and Pará in Brazil (Harada and Ketelhut 2009; Bezděčková et al. 2015).

(22) *Cyphomyrmex hamulatus* Weber, 1938
Figure 6C, D

Material examined. COLOMBIA: **Antioquia** • 12 workers; Amalfi; 06°54′11″N, 075°05′26.7″W; alt. 1010 m; 19 Dec. 1999; F. Serna leg.; UNAB 4750; **Antioquia** • 1 worker; Amalfi; 06°46′31″N, 075°05′33″W; alt. 1010 m; Jul–Oct. 1997; F. Serna leg.; UNAB 4750; **Antioquia** • 2 workers; Amalfi; 06°45′57.6″N, 075°06′25.02″W; alt. 955 m; Sep. 2006; M. A. Vanegas leg.; MEFLG 11080; **Antioquia** • 1 worker; Amalfi; 06°47′57.82″N, 075°07′18.96″W; alt. 1077 m; Nov. 2006; M. A. Vanegas leg.; MEFLG 11081; **Antioquia** • 5 gynes, 11 workers; Amalfi; 06°47′43″N, 075°07′56″W; alt. 1550 m; 27 Oct. 1997; F. Serna leg.; MEFLG 5843; **Antioquia** • 10 workers; Amalfi; 06°46′19.2″N, 075°05′26.44″W; alt. 1550 m; 30 Jul. 1997; F. Serna leg.; MEFLG 5843; **Caquetá** • 1 worker; El Doncello; 01°40′48″N, 075°17′06″W; alt. 500 m; 16 Nov. 2013; F. Serna leg.; UNAB 4368; **Caquetá** • 3 workers; Florencia; 01°25′34.7″N, 075°30′59″W; alt. 267 m; Sep. 2017; D. Mera-Rodríguez leg.; UNAB 4750; **Caquetá** • 2 workers; Florencia; 01°30′9.99″N, 075°36′23″W; alt. 250 m; 28 Sep. 2016; UNAB members leg.; UNAB 4369; **Sucre** • 2 workers; Ovejas; 09°32′4.1′00″N, 075°13′18.5″W; alt. 277 m; 4 Feb. 2016; H. Cadena leg.; MEFLG 40890–408901.

Identification. Frontal carina quite sinuous; all carina very sharp and somewhat foliaceous; promesonotal tubercles acutely pointed; hind femur angulates at basal third, posteroventral border with a narrow foliaceous crest; postpetiole with a shallow mid-dorsal impression, hairs on head and gaster recurvate or hook-like, not appressed; and tubercles on mesosoma sharply pointed (Kempf 1965).

Distribution. *Cyphomyrmex hamulatus* is distributed throughout Bolivia, Brazil (Amazonas and Pará), Colombia, Costa Rica, Peru, and Venezuela (Brandão 1991; Snelling and Longino 1992; Fernández and Sendoya 2004).

(23) *Cyphomyrmex laevigatus* Weber, 1938
Figure 6E, F

Material examined. COLOMBIA: **Caquetá** • 1 worker; Florencia; 01°30′9.99″N, 075°36′22″W; alt. 250 m; 28 Sep. 2016; UNAB members leg.; UNAB 4367.

Identification. Mesosoma completely unarmed, propodeum in profile evenly rounded; and petiolar node in dorsal view strikingly transverse, thrice as broad as long (Kempf 1965).

Distribution. *Cyphomyrmex laevigatus* is widely distributed in northern South America, including Bolivia, northern Brazil (Amazonas, Maranhão, Mato Grosso, Pará, and Rondônia), Colombia, Ecuador, Paraguay, Perú and Venezuela (Mayhé-Nuñes and Jaffé 1998; Souza et al. 2018).

(24) *Cyphomyrmex major* (Forel, 1901)
Figure 6G, H

Material examined. COLOMBIA: **Antioquia** • 3 gynes, 4 workers; Turbo; 08°05′53″N, 076°43′54″W; alt. 1 m; 15 Sep. 2004; O. Munar leg.; UNAB 2353; **Santander** • 4 gynes, 4 workers; Santa Helena del Opon; 06°20′00″N, 073°36′00″W; alt. 1426 m; Apr. 2012; A. Ardila leg.; UNAB 2526.

Identification. Mid-pronotal tubercle paired; cephalic posterolateral corner produced as broad lobe, not spine-like; frontal carina extending onto top lobe joining posterior carina; and anterior mesonotal tubercle high and obtuse (Snelling and Longino 1992).

Distribution. *Cyphomyrmex major* is known from Bolivia, Brazil (Amazonas, Rio Grande do Sul, Paraná, and São Paulo), Colombia, Costa Rica, Nicaragua, Panama, and Venezuela (Kempf 1972; Santos et al. 2017; Fernández and Serna 2019).

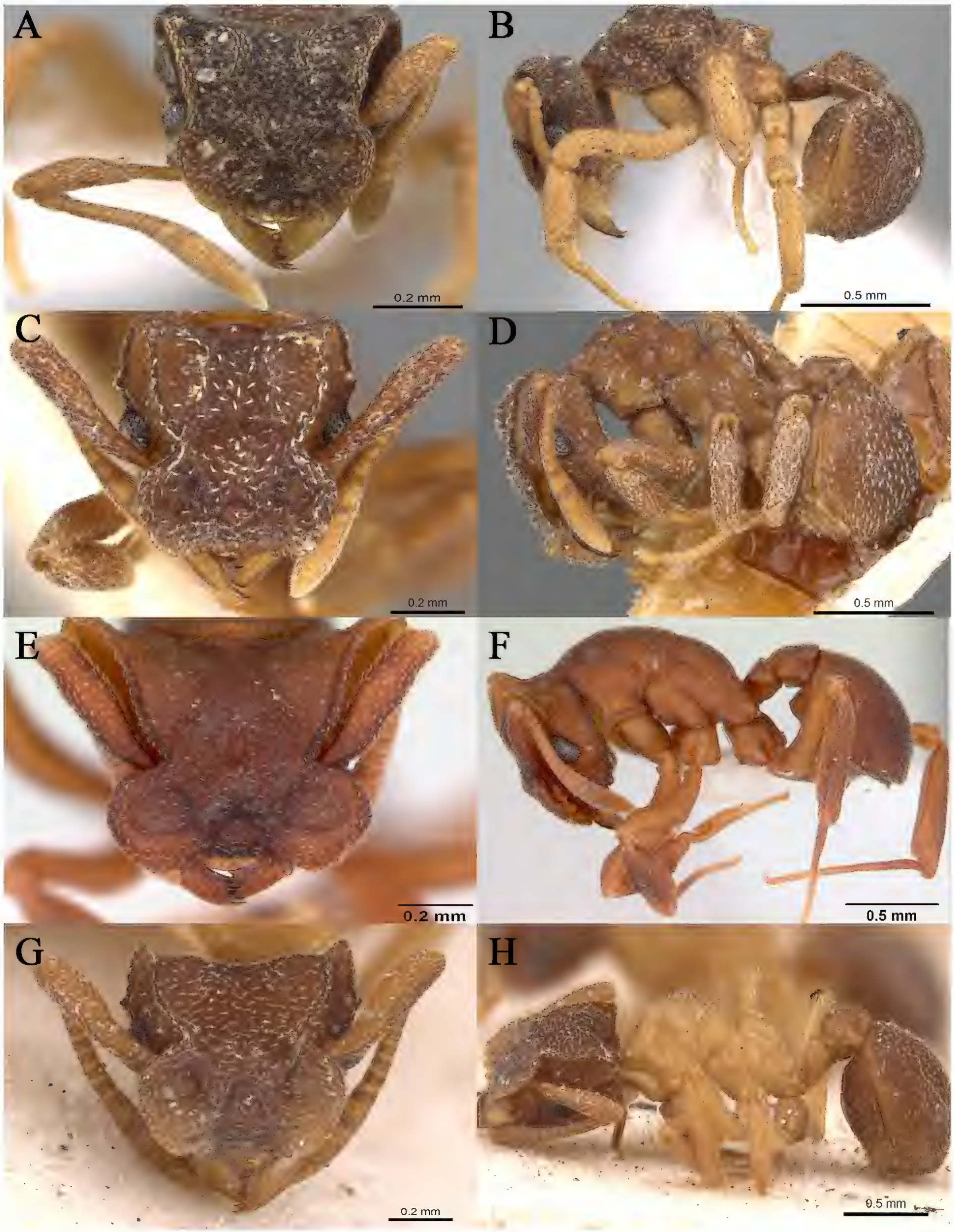

Figure 6. *Cyphomyrmex* species encountered in Colombia. **A, B.** *Cyphomyrmex costatus*, CASENT0281765/ S. Hartman. **C, D.** *Cyphomyrmex hamulatus*, CASENT0901673/ R. Perry. **E, F.** *Cyphomyrmex laevigatus*, CASENT0173956/ A. Nobile. **G, H.** *Cyphomyrmex major*, CASENT0909379/ W. Ericson. Photographs obtained from the Antweb database (http://www.antweb.org).

(25) *Cyphomyrmex minutus* Mayr, 1862

Figure 7A, B

Material examined. COLOMBIA: **Amazonas** • 1 worker; La Pedrera; 01°35′00″S, 069°28′00″W; alt. 87 m; 29 Apr.–7 May 2001; A. Sabogal leg.; UNAB 4755; **Antioquia** • 5 workers; Amalfi; 06°46′31″N, 075°05′33″W; alt. 1010 m; 08 May 1998; F. Serna leg.; UNAB 4751, 4753; **Antioquia** • 13 workers; Amalfi; 06°47′43″N, 075°07′56″W; alt. 1550 m; 27 Oct. 1997; F. Serna leg.;

MEFLG 5843; **Antioquia** • 4 workers; Amalfi; 06°47′43″N, 075°07′56″W; alt. 1550 m; 30 Jul. 1997; F. Serna leg.; MEFLG 5843; **Antioquia** • 2 workers; Medellín; 06°15′44.4″N, 075°34′33.4″W; alt. 1460 m; May 1999; MELFG members leg.; MEFLG 5890; **Antioquia** • 4 workers**;** Santafé de Antioquia; 06°33′41″N, 075° 49′54″W; alt. 600 m; 06 Oct. 2000; A. Miranda leg.; UNAB 4752; **Caquetá** • 1 worker; Florencia; 01°30′4″N, 075°39′42″W; alt. 280 m; Sep. 2017; UNAB members leg.; UNAB 4751; **Caquetá** • 34 workers; Florencia; 01°25′34″N, 075°30′59″W; alt. 267 m; Sep. 2017; D. Mera-Rodríguez leg.; UNAB 4751; **Caquetá** • 4 workers; Florencia; 01°30′4″N, 075°39′42″W; alt. 280 m; Sep. 2017; D. Mera-Rodríguez leg.; UNAB 4751, 4753; **Santander** • 1 gyne, 4 workers; San Vicente del Chucurí; 06°54′5″N, 073°44′8″W; alt. 102 m; F. Serna leg.; UNAB 4751.

Identification. Small individuals; head width 0.56 mm or less; hairs on disc of gaster closely appressed and mostly separated by more than their own lengths; and median basal groove of gaster short and usually indistinct (Snelling and Longino 1992).

Distribution. *Cyphomyrmex minutus* is one of the most widely distributed species of fungus-growing ants. It has been recorded from southern United States of America (Arizona, Texas, and Florida) all the way south to Argentina (Misiones) (Snelling and Longino 1992; Deyrup 2003, 2016; Fernández and Sendoya 2004; Salinas 2010; Demétrio et al. 2017). It is possible that *C. minutus* is a complex of cryptic species, but this hypothesis needs to be tested with a comprehensive sampling of populations from across the Americas.

(26) *Cyphomyrmex rimosus* (Spinola, 1851)
Figure 7C, D

Material examined. COLOMBIA: **Amazonas** • 1 worker; La Pedrera; 01°35′00″S, 069°28′00″W; alt. 87 m; 29 Apr.–7 May 2001; A. Sabogal leg.; UNAB 4755; **Antioquia** • 5 workers; Amalfi; 06°47′43″N, 075° 07′56″W; alt. 1550 m; 27 Oct. 1997; F. Serna leg.; MEFLG 5843; **Caquetá** • 4 workers; Florencia; 01°30′4″N, 075°39′42″W; alt. 280 m; Sep. 2017; D. Cubillos leg.; UNAB 4754; **Caquetá** • 1 worker; La Montanita; 01°28′25″N, 075°32′51″W; alt. 612 m; 27 Dec. 2015; D. Meneses leg.; UNAB 3900; **Cundinamarca** • 1 worker; Choachi; 04°31′52″N, 073°55′33″W; alt. 1927 m; 04 Nov. 2013; M. Forero leg.; UNAB 4754; **Huila** • 1 worker; El Pital; 02°20′53″N, 075°47′55″W; alt. 921 m; 02 Nov. 2009; D. Briceno leg.; UNAB 4754.

Identification. Large individuals, head width more than 0.62 mm; hairs of gaster coarse, not fully appressed and mostly separated by less than their own lengths; and basal groove of gaster distinct and more than twice as long as wide (Snelling and Longino 1992).

Distribution. Similar to *C. minutus, C. rimosus* is also widely distributed in the Americas, its distribution extends from southern United States of America, throughout Central and South America to Argentina (Buenos Aires and Mendoza) (Kempf 1972; Fernández and Sendoya 2004). A thorough taxonomic study needs to test whether *C. rimosus* is a single biological species, or whether it is a complex of cryptic species.

Mycocepurus Forel, 1893

(27) *Mycocepurus smithii* (Forel, 1893)
Figure 7E, F

Material examined. COLOMBIA: **Antioquia** • 1 worker; Amalfi; 06°45′42.23″N, 075°05′31.57″W; alt. 983 m; Sep. 2006; M.A. Vanegas leg.; MEFLG 11088; **Antioquia** • 1 worker; Santafé de Antioquia; 06°33′41″N, 075° 49′54″W; alt. 600 m; 06 Oct. 2000; E. Vergara, F. Serna leg.; UNAB 4756; **Antioquia** • 2 workers; Turbo; 08°05′53″N, 076°43′54″W; alt. 1 m; 15 Sep. 2004; O. Munar leg.; UNAB 4756; **Caquetá** • 2 workers; Florencia; 01°37′11″N, 075°36′14″W; alt. 300 m; 31 Mar. 2016; F. Serna leg.; UNAB 4357; **Caquetá** • 5 workers; Florencia; 01° 30′4″N, 075°39′42″W; alt. 280 m; Sep. 2017; UNAB leg.; UNAB 4756.

Identification. Pronotum with a pair of anterior pronotal spines, which define the anterior border of a crown of spines on the promesonotum; promesonotal disc lacking spines; lateral pronotal spines high and sharp; and propodeal spines usually straight (Mackay et al. 2004).

Distribution. *Mycocepurus smithii* is widely distributed throughout Central and South America, extending from Mexico all the way south to Argentina including many Caribbean islands (Kempf 1972; Fernández et al. 1996; Mackay et al. 2004; Rabeling et al. 2011; Franco and Feitosa 2018).

Myrmicocrypta Smith, 1860

(28) *Myrmicocrypta urichi* Weber, 1937
Figure 7G, H

Material examined. COLOMBIA: **Antioquia** • 1 worker; Santafé de Antioquia; 06°33′41″N, 075°49′54″W; alt. 600 m; Nov. 2017; D. Mera-Rodríguez leg.; UNAB 4758; **Caquetá** • 12 workers; Florencia; 01°30′9.99″N, 075°36′ 23″W; alt. 250 m; 28 Sep. 2016; UNAB members leg.; UNAB 4358; **Caquetá** • 12 workers; Florencia; 01°37′ 11″N, 075°36′14″W; alt. 300 m; 31 Mar. 2016; F. Serna leg.; UNAB 4358; **Caquetá** • 3 workers; Florencia; 01°25′34″N, 075°30′59″W; alt. 267 m; Sep. 2017; D. Mera-Rodríguez leg.; UNAB 4758; **Caquetá** • 15 workers; Florencia; 01°30′4″N, 075°39′42″W; alt. 280 m; Sep. 2017; UNAB members leg.; UNAB 4758; **Caquetá** • 6 workers; Florencia; 01°25′34″N, 075°30′59″W; alt. 267 m; Sep. 2017; D. Cubillos leg.; UNAB 4758; **Caquetá** • 17 workers; Florencia; 01°30′4″N, 075°39′42″W; alt. 280 m; Sep. 2017; UNAB members leg.; UNAB 4758; **Caquetá** • 25 workers; Florencia; 01°30′4″N, 075°39′42″W; alt. 280 m; Sep. 2017; D. Pantoja leg.; UNAB 4758; **Caquetá** • 18 workers; Florencia; 01°25′34″N, 075°30′59″W; alt. 267 m; Sep. 2017; F. Serna, D. Cubillos leg.; UNAB 4758; **Caquetá** • 3 workers; Florencia; 01°30′4″N, 075°39′42″W; alt. 280 m; Sep.

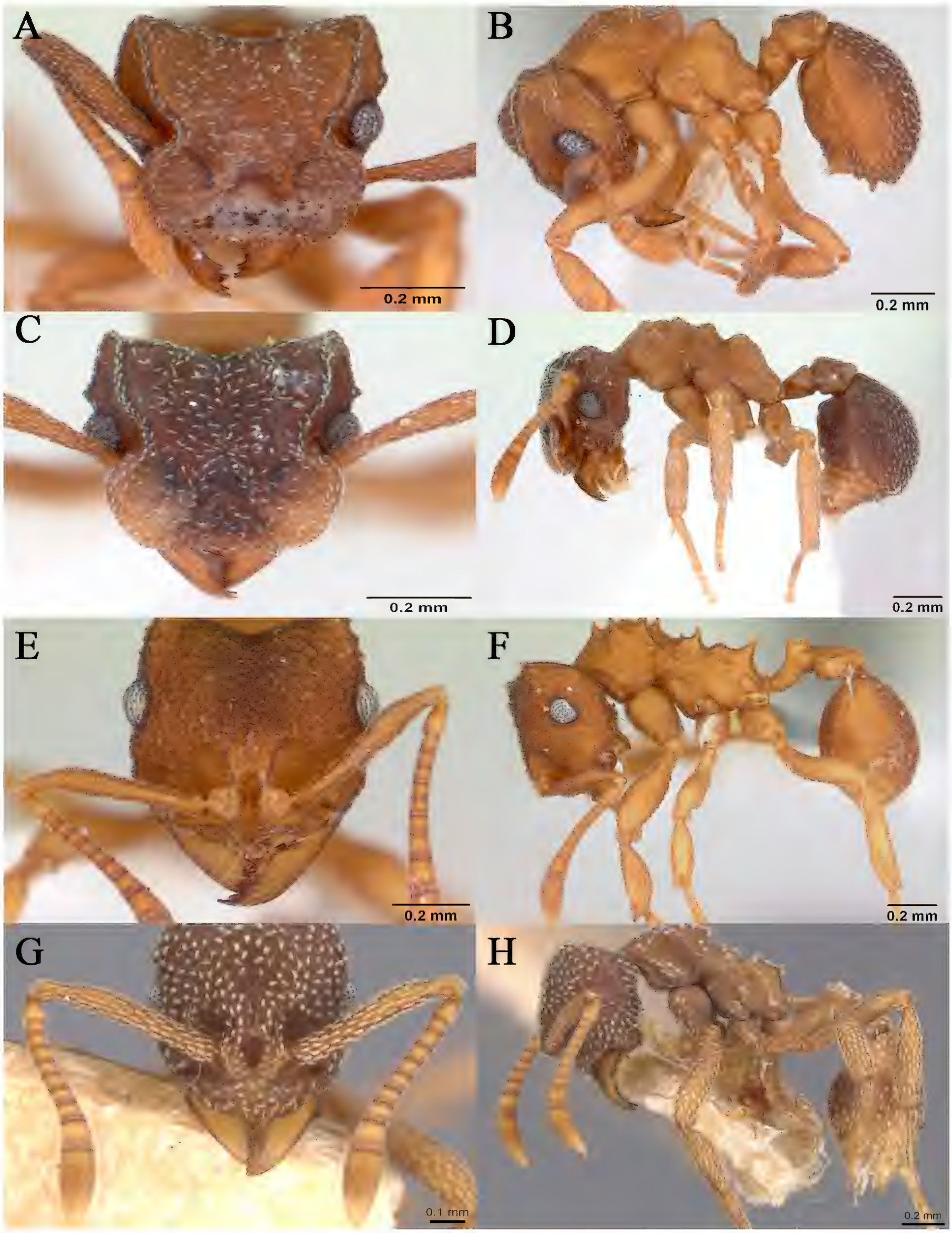

Figure 7. *Cyphomyrmex*, *Mycocepurus*, and *Myrmicocrypta* species encountered in Colombia. **A, B.** *Cyphomyrmex minutus*, CASENT0173957. **C, D.** *Cyphomyrmex rimosus*, CASENT0173243. **E, F.** *Mycocepurus smithii*, CASENT0173989. **G, H.** *Myrmicocrypta urichi*, CASENT0912513. Photographs taken by A. Nobile (**A–F**) and W. Ericson (**G, H**) obtained from the Antweb database (http://www.antweb.org).

2017; F. Serna, D. Cubillos Leg.; UNAB 4758; **Caquetá** • 9 workers; Florencia; 01°25′34″N, 075°30′59″W; alt. 267 m; Sep. 2017; D. Mera-Rodríguez leg.; UNAB 4758; **Caquetá** • 6 workers; Florencia; 01°30′4″N, 075°39′42″W; alt. 280 m; Sep. 2017; D. Mera-Rodríguez leg.; UNAB 4758.

Identification. Dark brown ants; body covered by scales; apical mandibular tooth in anterior view as long as preapical tooth; clypeus, front and frontal lobes densely covered with scales; postpetiole in dorsal view shaped as longitudinal half of an ellipse; and postpetiole 2.5×

broader than long (Sosa-Calvo 2015).

Distribution. *Myrmicocrypta urichi* occurs in Colombia, the Lesser Antilles, and Venezuela (Kempf 1972; Sosa-Calvo 2015).

(29) *Myrmicocrypta* sp. 1

Material examined. COLOMBIA: **Cesar** • 2 workers; Guacoche; 10°40′55″N, 073°17′29″W; alt. 250–150 m; Jan. 2011; Y. Dominguez leg.; UNAB 4757.

Comment. This is a new species only known from two workers and will be described in a forthcoming taxonomic study. This species corresponds to species *Myrmicocrypta* ca. *ednaella* in Sosa-Calvo (2015).

Sericomyrmex Mayr, 1865

(30) *Sericomyrmex amabilis* Wheeler, 1925
Figure 8A, B

Material examined. COLOMBIA: **Antioquia** • 4 workers; Santafé de Antioquia; 06°33′41″N, 075°49′54″W; alt. 600 m; 06 Oct. 2000; E. Vergara, F. Serna leg.; UNAB 4759; **Amazonas** • 3 workers; La Pedrera; 01°35′00″S, 069°30′00″W; alt. 87 m; 12–21 Apr. 2001; A. Sabogal leg.; UNAB 4759; **Caquetá** • 4 workers; Florencia; 01°37′11″N, 075°36′14″W; alt. 300 m; 31 Mar. 2016; F. Serna leg.; UNAB 4364; **Caquetá** • 3 workers; Florencia; 01°30′4″N, 075°39′42″W; alt. 280 m; Sep. 2017; UNAB members leg.; UNAB 4759; **Caquetá** • 1 worker; Florencia; 01°30′4″N, 075°39′42″W; alt. 280 m; Sep. 2017; D. Cubillos leg.; UNAB 4759; **Chocó** • 1 worker; Lloró; 05°29′00″N, 076°32′00″W; alt. 90 m; 26 Nov. 1998; J. Neita, M. Renteria leg.; MEFLG 5902; **Chocó** • 6 workers; Unguía; 08°02′00″N, 077°05′00″W; alt. 7 m; Jan. 2002; F. Serna leg.; UNAB 4759; **Meta** • 1 worker; Puerto Lopez; 04°17′31″N, 072°33′40″W; alt. 182 m; 21 Apr. 2011; M. Montanez leg.; UNAB 4759; **Tolima** • 1 worker; Guamo; 04°02′05″N, 074°58′25″W; alt. 323 m; 18 Aug. 2003; F. Serna, E. Díaz leg.; UNAB 4759; **Tolima** • 1 worker; Icononzo; 04°10′32″N, 074°32′00.5″W; alt. 480 m; 1 Jul. 1997; C. Sarmiento leg.; MEFLG 5381.

Identification. Medium-sized species; mandible usually striate; frontal carina complete; frontal lobe triangular; eye almost flat, without white layer; posterior cephalic margin with abrupt to gradual emargination; mesosomal tubercles from low and obtuse to well-developed; and gaster with lateral carina strongly developed, dorsal carina from weak to well-developed (Ješovnik and Schultz 2017).

Distribution. *Sericomyrmex amabilis* is present in Central America and occurs from San Luis Potosí in Mexico to Panama. In South America, *S. amabilis* has been reported from Colombia, Ecuador, and Venezuela (Wheeler 1925; Ješovnik and Schultz 2017).

(31) *Sericomyrmex bondari* Borgmeier, 1937
Figure 8C, D

Material examined. COLOMBIA: **Antioquia** • 1 worker; Andes; 05°41′00″N, 075°50′00″W; alt. 1700 m; 09 Mar. 2017; M. Ramirez leg.; UNAB 4760; **Amazonas** • 1 worker; La Pedrera; 01°35′00″S, 069°28′00″W; alt. 87 m; 29 Apr.–7 May 2001; A. Sabogal leg.; UNAB 4760; **Caquetá** • 2 workers; Florencia; 01°30′9.99″N, 075°36′23″W; alt. 250 m; 21 Sep. 2016; F. Serna leg.; UNAB 363; **Putumayo** • 1 worker; Mocoa; 01°08′00″N, 076°38′00″W; alt. 500 m; 11–13 Jun. 2002; UNAB members leg.; UNAB 4773; **Vaupés** • 1 worker; Taraira; 01°04′00″S, 069°31′00″W; alt. 85 m; 14–20 May 2001; A. Sabogal leg.; UNAB 4760.

Identification. Large species; hairs thick and dark; posterior cephalic emargination deep, gradually impressed; posterior cephalic corner acute to rounded; mandible dorsally smooth; frontal lobe triangular; mesosomal tubercles distinct, sometimes relatively sharp; and gaster with lateral carina weakly to moderately developed, and dorsal carina absent (Ješovnik and Schultz 2017).

Distribution. *Sericomyrmex bondari* is widely distributed throughout South America and has been recorded in Bolivia, the Brazilian states of Amazonas, Bahia, Ceará, Espírito Santo, Mato Grosso, Minas Gerais, Pernambuco, Rio de Janeiro, and Rondônia, as well as in Colombia, Ecuador, French Guiana, Guyana, Peru, Suriname, and Venezuela (Borgmeier 1937; Ješovnik and Schultz 2017).

(32) *Sericomyrmex mayri* Forel, 1912
Figure 8E, F

Material examined material. COLOMBIA: **Antioquia** • 1 worker; Amalfi; 06°46′19.2″N, 075°05′24.4″W; alt. 1550 m; 1 Jul. 1998; F. Serna leg.; MEFLG 5901; **Antioquia** • 3 workers; Amalfi; 06°45′57.6″N, 075°06′25.02″W; alt. 955 m; Sep. 2006; M.A. Vanegas leg.; MEFLG 5901; **Antioquia** • 1 worker; Amalfi; 06°47′48.92″N, 075° 06′55.56″W; alt. 1113 m; 2 Oct. 1998; F. Serna leg.; MEFLG 5901; **Antioquia** • 3 workers; Amalfi; 06°47′48.92″N, 075°06′55.56″W; alt. 1113 m; 1997; F. Serna leg.; MEFLG 5901; **Antioquia** • 1 worker; San Carlos; 06°11′29″N, 074°59′43″W; alt. 1036 m; 05 Jan. 2007; N. Vergara, C. Gómez leg.; UNAB 4774; **Sucre** • 3 workers; Ovejas; 09°32′4.1″N, 075°13′18.5″W; alt. 277 m; 4 Feb. 2016; H. Cadena leg.; MEFLG 40894, 40893, 40892.

Identification. Large species; head broad; frontal lobe narrow; mandible usually striate; frontal carina often incomplete; eye flat to mildly convex; posterior cephalic margin shallow, abruptly to gradually impressed; posterior cephalic corner usually angled; mesosomal tubercles low and obtuse; and gaster with lateral carina well-developed, dorsal carina absent or faint (Ješovnik and Schultz 2017).

Distribution. *Sericomyrmex mayri* has been recorded from Bolivia, the northern states of Brazil, Colombia, Ecuador, Peru, and Venezuela. In Central America, *S. mayri* is only known in Panama (Forel 1912; Ješovnik and Schultz 2017).

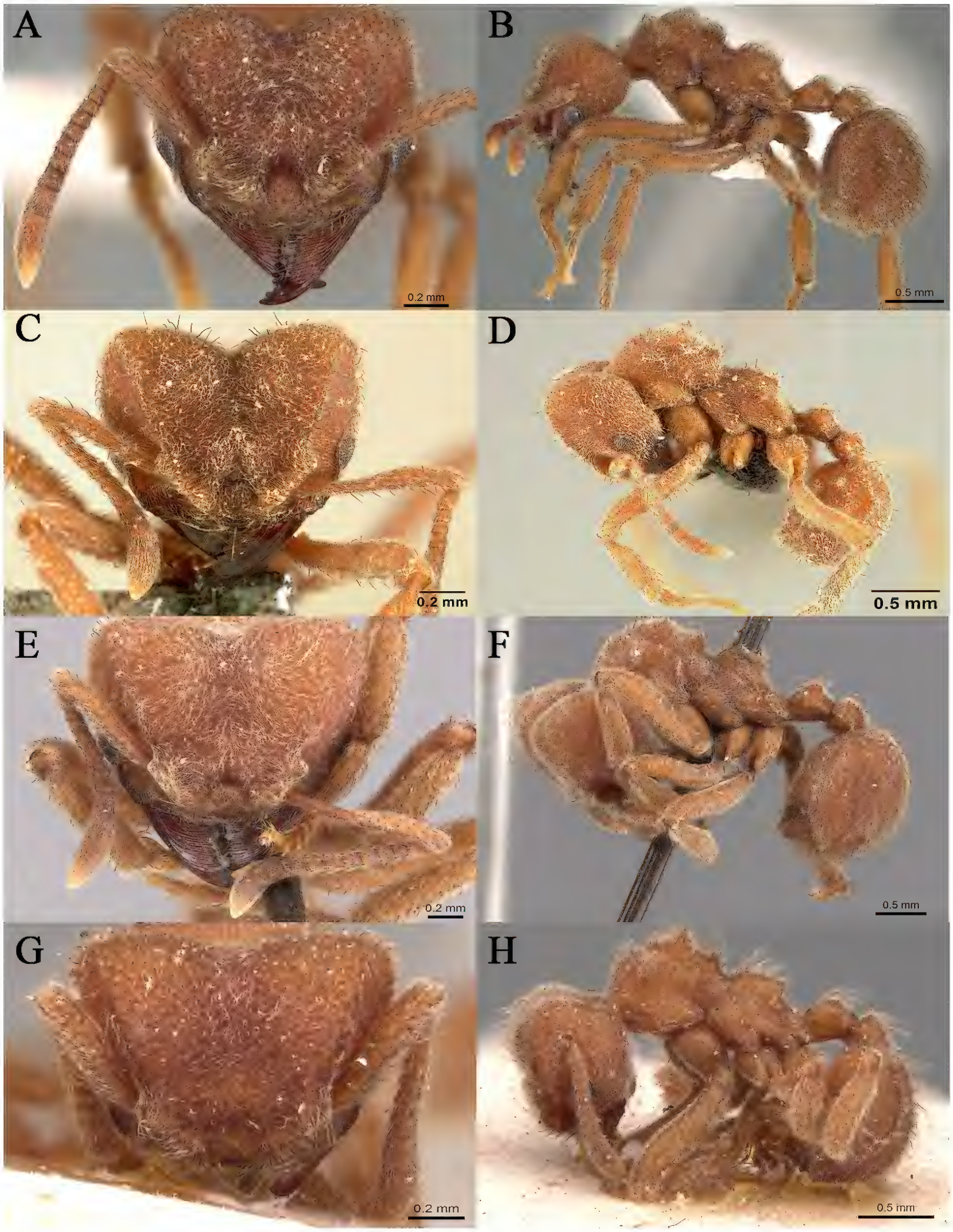

Figure 8. *Sericomyrmex* species encountered in Colombia. **A, B.** *Sericomyrmex amabilis*, CASENT0922156/ M. Esposito. **C, D.** *Sericomyrmex bondari*, USNMENT01125823/ A. Ješovnik. **E, F.** *Sericomyrmex mayri*, CASENT0909370/ W. Ericson. **G, H.** *Sericomyrmex saussurei*, USNMENT00445513/ W. Ericson. Photographs obtained from the Antweb database (http://www.antweb.org).

(33) *Sericomyrmex saussurei* Emery, 1894
Figure 8G, H

Material examined. COLOMBIA: **Amazonas** • 2 workers; La Pedrera; 01°35′00″S, 069°30′00″W; alt. 87 m; 12–21 Apr. 2001; A. Sabogal leg.; UNAB 4761; **Santander** • 1 worker**;** Santa Helena del Opón; 06°20′ 00″N, 073°36′00″W; alt. 1426 m; 01 Apr. 2012; A. Ardila leg.; UNAB 2528.

Identification. Medium-sized species; mandible usually striate; frontal carina complete; frontal lobe triangular; eye convex, moderately protruding from sides of head, covered with thick white layer; posterior cephalic emargination abruptly to gradually impressed, mesosomal tubercles from low and obtuse to well developed; and gaster with lateral carina well developed, and dorsal carina weak to well developed (Ješovnik and Schultz 2017).

Distribution. *Sericomyrmex saussurei* is widely distributed throughout the Amazon basin (Emery 1894; Kempf 1972; Ješovnik and Schultz 2017).

Mycetomoellerius Solomon et al., 2019

(34) *Mycetomoellerius jamaicensis* (Andre, 1893)
Figure 9A, B

Material examined. COLOMBIA: **Magdalena** • 27 workers**;** Pivijay; 10°27′00″N, 074°36′00″W; alt. 3 m; Nov. 1985; A. Madrigal leg.; MEFLG 4272; **Magdalena** • 14 workers; Pivijay; 10°27′00″N, 074°36′00″W; alt. 3 m; May 1986; A. Madrigal leg.; MEFLG 4822.

Identification. Antennal scapes surpass posterior corners of head by 1–2 times their maximum diameter; clypeus with row of coarse, long hairs on anterior margin; in side view, a few shorter erect hairs often present posterior to the anterior row; preocular carina relatively short, stopping at about 1/3 the distance between eye and posterior corner of head; frontal carina long, reaching back to posterior corner of head; anterolateral promesonotal tooth long, sharply pointed, projecting forward and upwards; propodeal teeth sharply pointed, approximately as long as the distance between their bases; gaster strongly tuberculated, in dorsal view tubercles form four more or less distinct longitudinal ridges on first gastric tergite; and color dark reddish-black or gray-black, appendages and two petiolar segments usually a lighter reddish-brown (Rabeling et al. 2007).

Distribution. *Mycetomoellerius jamaicensis* was previously recorded from the Caribbean island arc, Florida (USA), and Venezuela (Deyrup 2003, 2016; Jaffé and Lattke 1994; Mayhé-Nuñes and Brandão 2007; Rabeling et al. 2007). Our new record from Magdalena department in northern Colombia extends the distribution along the northern South American mainland (Fig. 1C).

(35) *Mycetomoellerius urichii* (Forel, 1893)
Figure 9C, D

Material examined. COLOMBIA: **Cesar** • 1 worker**;** Valledupar; 10°23′17″N, 073°14′11″W; alt. 250 m; Mar. 2011; Y. Dominguez leg.; UNAB.

Identification. Head square, as wide as long; mandibles subopaque smooth and sparsely punctuated at apex, indistinctly denticulate at the terminal border; median pronotal spines tuberculated; lateral pronotal spines slender and with small tubercles; mesonotum with four tuberculated spines; and propodeal spines robust and with small tubercles (Forel 1893; Fernández and Serna 2019).

Distribution. *Mycetomoellerius urichii* is present in Colombia, French Guiana, Guyana, the Lesser Antilles, Panama, Suriname, Venezuela, and much of Brazil (Bahia, Goiás, Mato Grosso, Mato Grosso do Sul, Minas Gerais, Santa Catarina, São Paulo, Rio de Janeiro, and Tocantins) (Kempf 1972; Fernández and Sendoya 2004).

(36) *Mycetomoellerius* sp. 1

Material examined. COLOMBIA: **Antioquia** • 1 worker; Amalfi; 06°57′8.02″N, 075°00′48″W; alt. 1020 m; 27 Oct. 1997; F. Serna leg.; UNAB 5452; **Atlántico** • 1 worker; Juan de Acosta; 10°46′02″N, 075°02′34″W; alt. 117–250 m; Feb.–May 2012; J. Castro, S. Royero leg.; UNAB 5452; **Chocó** • 1 worker; Unión Panamericana; 05°21′37.48″N, 076°38′45.35″W; alt. 119 m; 08 May 2001; J. Neita leg.; UNAB 5452; **Sucre** • 1 worker; Colosó; 09°29′44″N, 075° 23′17″W; alt. 200–700 m; Aug. 2009; G. Mercado leg.; UNAB 5452.

Comment. This *Mycetomoellerius* species represents a new species and needs to be described in the context of a taxonomic revision.

Paratrachymyrmex Solomon et al., 2019

(37) *Paratrachymyrmex bugnioni* (Forel, 1912)
Figure 9E, F

Material examined. COLOMBIA: **Atlántico** • 1 worker; Juan de Acosta; 10°46′02″N, 075°02′34″W; alt. 177–250 m; Aug. 2012; D. Serna leg.; UNAB 4762.

Identification. Frons and vertex strongly longitudinally rugose; apex of antennal scape scarcely surpassing the posterior cephalic corner; constriction of the frontal carina immediately beyond of the frontal lobes is not present; and distance between the frontal carina is half of the maximum width of the head as measured across the eyes (unpublished key by Kempf).

Distribution. *Paratrachymyrmex bugnioni* has been recorded from Mexico (Jalisco) and Guatemala south to Brazil (Amazonas, Goiás, Maranhão, Minas Gerais, Pará, and Roraima) (Kempf 1972; Fernández and Sendoya 2004; Achury and Suárez 2018; Souza et al. 2018).

(38) *Paratrachymyrmex cornetzi* (Forel, 1912)
Figure 9G, H

Material examined. COLOMBIA: **Antioquia** • 6 workers; Amalfi; 06°59′30″N, 074° 59′54″W; alt. 1550 m; 30 Jul. 1997; F. Serna leg.; UNAB 4763; **Antioquia** • 1 worker; Amalfi; 06°51′26″N, 075°05′40″W; alt. 970 m; 19 Dec. 1999; E. Vergara leg.; UNAB 4763; **Antioquia** • 11 workers; Amalfi; 06°59′30″N, 074°59′54″W; alt. 1550 m; 27 Oct. 1997; F. Serna leg.; UNAB 4763; **Antioquia** • 1 worker; Amalfi; 06°51′00″N, 075°05′00″W; alt. 970 m; 30 Jul. 1997; F. Serna leg.; UNAB 4763; **Antioquia** • 2 workers; Amalfi; 06°35′54″N, 075°01′17″W; alt. 1010 m; 30 Jul. 1997; F. Serna leg.; UNAB 4763; **Antioquia** • 1 worker; Amalfi; 06°51′00″N, 075°05′00″W; alt. 970 m; 27 Oct. 1997; F. Serna leg.; UNAB 4763; **Antioquia** • 2 workers; Amalfi; 06°35′54″N, 075°01′17″W; alt. 1010

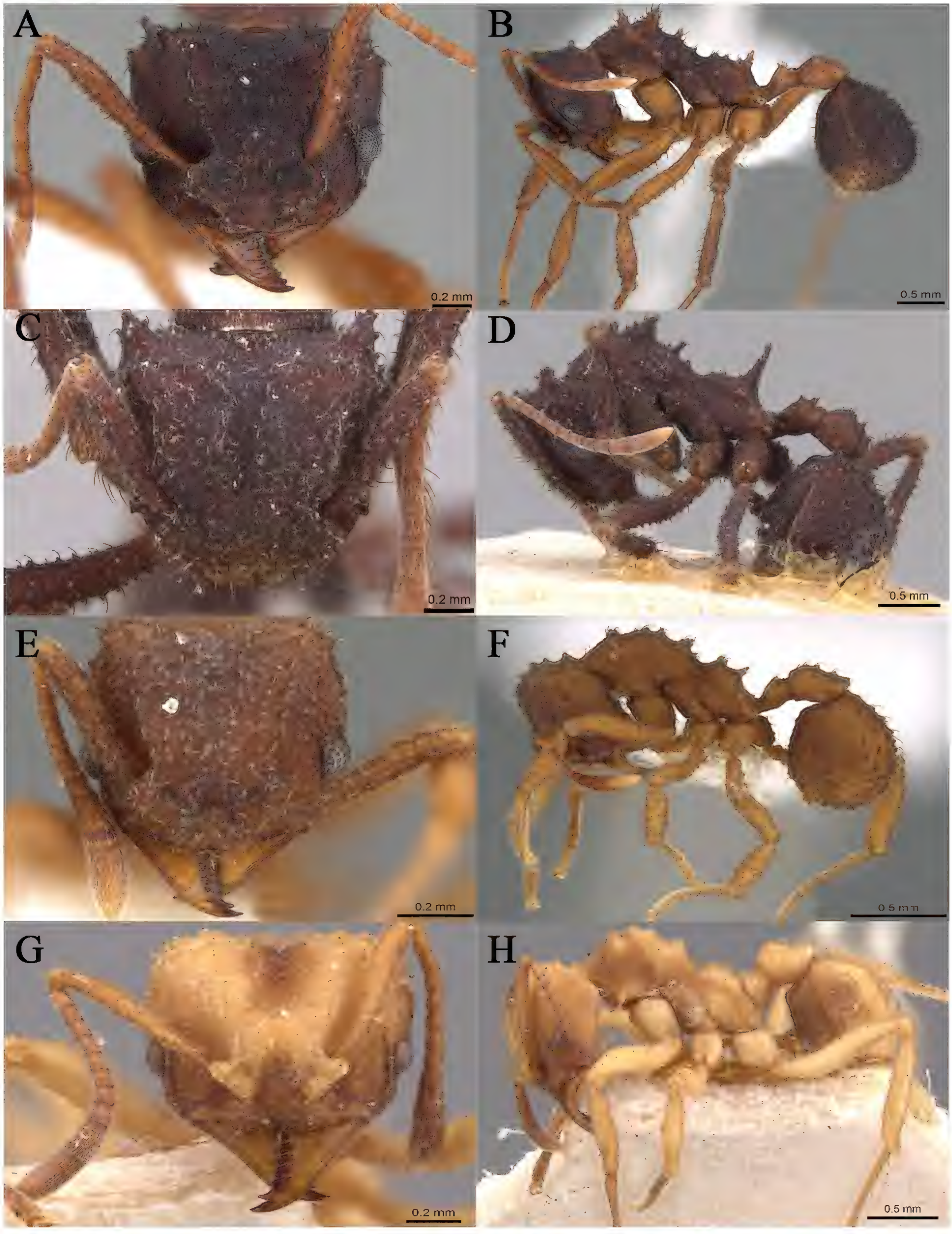

Figure 9. *Mycetomoellerius* and *Paratrachymyrmex* species encountered in Colombia. **A, B.** *Mycetomoellerius jamaicensis*, CASENT0919971/ M. Esposito. **C, D.** *Mycetomoellerius urichii*, CASENT0904990/ W. Ericson. **E, F.** *Paratrachymyrmex bugnioni*, CASENT0919968/ M. Esposito. **G, H.** *Paratrachymyrmex cornetzi*, CASENT0909389/ W. Ericson. Photographs obtained from the Antweb database (http://www.antweb.org).

m; 08 Oct. 1997; F. Serna leg.; UNAB 4763; **Antioquia** • 1 worker; Amalfi; 06°35′54″N, 075°01′17″W; alt. 1010 m; 09 Oct. 1997; F. Serna leg.; UNAB 4763; **Antioquia** • 5 workers; Amalfi; 06°47′43″N, 075°07′56″W; alt. 1550 m; 30 Jul. 1997; F. Serna leg.; MEFLG 5918; **Antioquia** • 3 workers; Amalfi; 06°46′39″N, 075°05′22.9″W; alt. 950 m; 27 Oct. 1997; F. Serna leg.; MEFLG 5918; **Antioquia** • 1 worker; Amalfi; 06°46′39″N, 075°05′22″W; alt. 1550 m; 30 Jul. 1997; F. Serna leg.; MEFLG 5918; **Antioquia** • 1 worker; Amalfi; 06°46′19″N, 075°05′26″W; alt. 1550

m; 7 Nov. 1998; E. Vergara leg.; MEFLG 5918; **Antioquia** • 1 gyne; Amalfi; 06°46′19″N, 075°05′26.4″W; alt. 1550 m; 8 Oct. 1997; E. Vergara leg.; MEFLG 5918; **Antioquia** • 1 gyne; Amalfi; 06°46′19″N, 075°05′26.4″W; alt. 1550 m; 1 Jul. 1998; E. Vergara leg.; MEFLG 5918; **Antioquia** • 4 workers**;** Canyon del Porce; 06°35′54″N, 075°01′17″W; alt. 1010 m; 28 Oct. 1997; F. Serna leg.; UNAB 4766; **Santander** • 1 worker; Santa Helena del Opon; 06°20′00″N, 073°36′00″W; alt. 1426 m; Apr. 2012; A. Ardila leg.; UNAB 2525; **Tolima** • 1 worker; Guamo; 04°02′05″N, 074°58′25″W; alt. 323 m; 19 Aug. 2003; F. Serna, E. Díaz leg.; UNAB 4763.

Identification. Frontal lobes triangular; maximum distance between frontal carina is less than the distance between the frontal lobes; and posterior postpetiolar margin in dorsal view emarginate with two prominent tubercles (unpublished key by Kempf).

Distribution. *Paratrachymyrmex cornetzi* occurs in Mexico (Jalisco and Tabasco), Costa Rica, Guatemala, Honduras, Nicaragua, and Panama. In South America, it is present in Colombia, Ecuador, French Guiana, Guyana, Peru, Suriname, Venezuela and the Brazilian states of Amazonas, Roraima, Rondônia, Bahia, Minas Gerais, Rio de Janeiro, and Mato Grosso do Sul (Fernández and Sendoya 2004; Branstetter and Sáenz 2012; Souza et al. 2018).

(39) *Paratrachymyrmex diversus* (Mann, 1916)
Figure 10A, B

Material examined. COLOMBIA: **Caquetá** • 12 workers; Cartagena del Chaira; 01°22′02″N, 074°49′04″W; alt. 278 m; 28 Sep. 2016; UNAB members leg.; UNAB 4359; **Caquetá** • 12 workers; Florencia; 01°30′9.99″N, 075°36′23″W; alt. 250 m; 22 Sep. 2016; UNAB members leg.; UNAB 4359; **Caquetá** • 3 workers; Florencia; 01°30′9.99″N, 075°36′23″W; alt. 250 m; 21 Sep. 2016; F. Serna leg.; UNAB 4359; **Caquetá** • 1 worker; Florencia; 01°37′11″N, 075°36′14″W; alt. 300 m; 31 Mar. 2016; F. Serna leg.; UNAB 4359; **Caquetá** • 1 worker**;** Florencia; 01°30′9.99″N, 075°36′23″W; alt. 250 m; 22 Sep. 2016; UNAB members leg.; UNAB 4359; **Caquetá** • 12 workers**;** Florencia; 01°25′34″N, 075°30′59″W; alt. 267 m; Sep. 2017; D. Mera-Rodríguez leg.; UNAB 4764; **Caquetá** • 12 workers; Florencia; 01°25′34″N, 075°30′59″W; alt. 267 m; Sep. 2017; D. Cubillos leg.; UNAB 4764.

Identification. Cephalic spines in lateral view robust, long and curved at apex; dorsum of propodeum with only one pair of, sometimes bifid, teeth; node of petiole in lateral view with oblique anterodorsal margin ending in a pair of robust posterodorsal spines; gaster with appressed hairs as well as short curved hairs; and hairs on legs appressed and curved with the apex reaching the tegument (unpublished key by Kempf).

Distribution. The distribution of *P. diversus* includes northern Brazil, Ecuador, and Venezuela (Kempf 1972; Brandão 1991; Fernández and Sendoya 2004; Ryder Wilkie et al. 2010). Our new distribution records for Colombia (Fig. 1D) corroborates the northern South American distribution for this species.

(40) *Paratrachymyrmex irmgardae* (Forel, 1912)
Fig. 10C, D

Material examined. COLOMBIA: **Cesar** • 1 worker; Valledupar; 10°23′17″N, 073°14′11″W; alt. 250–150 m; Jan. 2011; Y. Dominguez leg.; UNAB 765.

Identification. Cephalic denticle absent; mandibles striate but with no more than 12 striae between the lateral border and the basal teeth; and gaster with vestigial or no hair-tubercles (unpublished key by Kempf).

Distribution. *Paratrachymyrmex irmgardae* is only known from Colombia (Fig. 1D) (Kempf 1972).

(41) *Paratrachymyrmex phaleratus* (Wheeler, 1925)
Fig. 10E, F

Material examined. COLOMBIA: **Antioquia** • 1 worker; Amalfi; 06°55′00″N, 075°04′00″W; alt. 1010 m; 27 Oct. 1997; F. Serna leg.; UNAB 5452.

Identification. Posterolateral cephalic corner with clearly distinct spine; mid-pronotal teeth present and separated from each other at the base; third pair of mesonotal spines distinct; and metasternal lamina dorsally rounded (unpublished key by Kempf).

Distribution. *Paratrachymyrmex phaleratus* was previously recorded in Guyana and Venezuela (Wheeler 1925; Mayhé-Nunes and Jaffé 1998), thus our new record for Colombia expands the geographic range of the species to the northwest Andean mountains (Fig. 1D).

Discussion

The importance of biological collections for studying biodiversity is underscored. In our study of the fungus-growing ants housed at two of the main entomological collections in Colombia, we were able to identify a total of 41 species of non-leaf-cutting fungus-growing ants from 38 municipalities in Colombia, including distinct biogeographic regions such as the Orinoco, the Caribbean coast, the Pacific coast, the Andean mountains, and the Amazonian basin. Our study reveals the existence of five apparent new species and reports four new species records from Colombia. If we add to our results the species of non-leaf-cutting fungus-farming ants reported in Fernández and Serna (2019) but not encountered in this study, and the 12 species of leaf-cutting ants known to occur in the country (Fernández et al. 2015), we have a total of 85 fungus-growing ant species for Colombia. Colombia harbors approximately one-third of the known fungus-growing ant richness, which is higher than the neighboring countries of similar size and geographic location. For Venezuela, 54 fungus-growing ant species have been recorded (Fernández and Sendoya 2004; Guénard et al. 2017; Antweb 2020) and in Ecuador 51 fungus-growing ant species are known to occur (Fernández and Sendoya 2004; Salazar et al. 2015; Guénard et al.

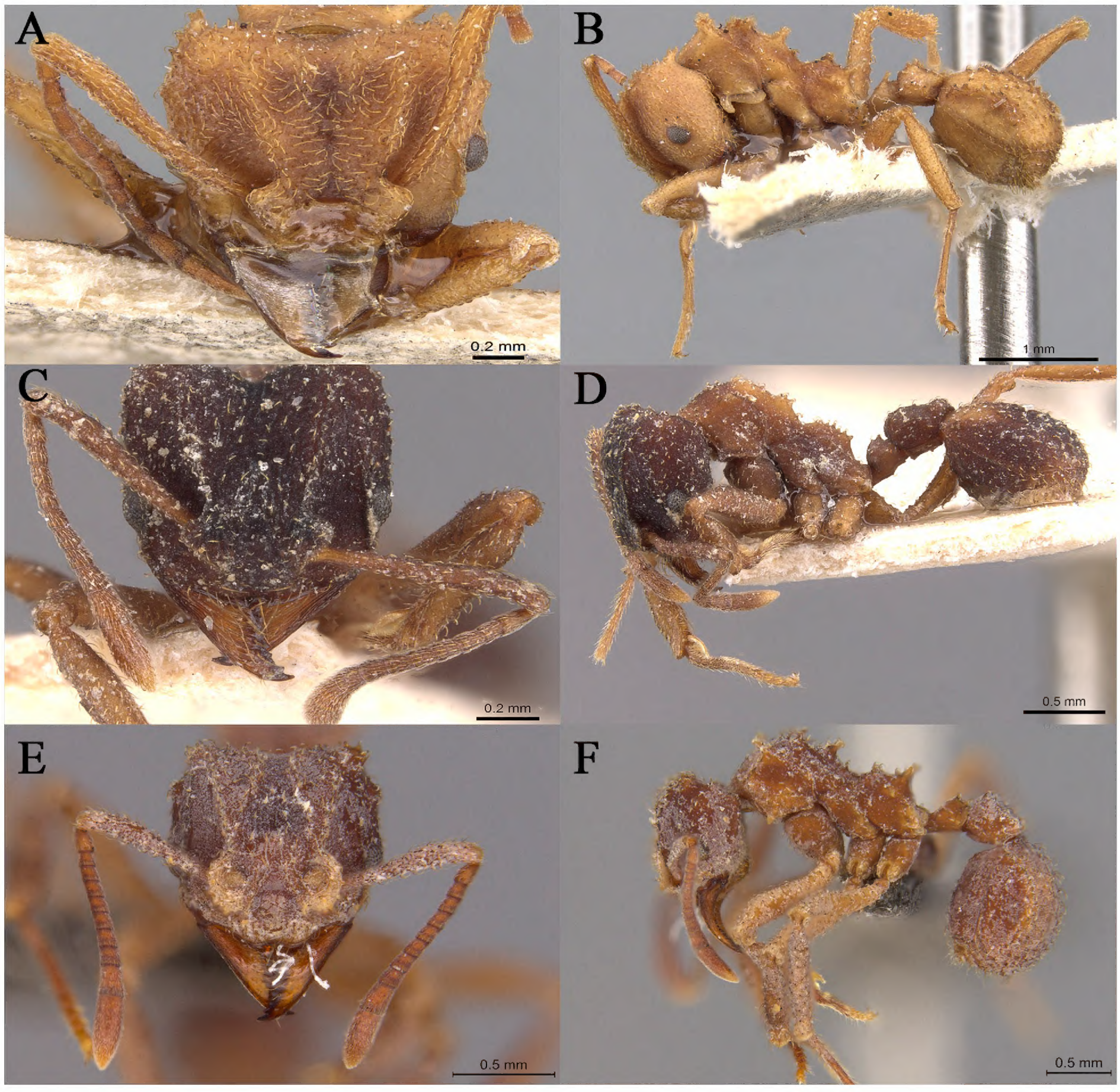

Figure 10. *Paratrachymyrmex* species encountered in Colombia. **A, B.** *Paratrachymyrmex diversus*, CASENT0901693. **C, D.** *Paratrachymyrmex irmgardae*, CASENT0909392. **E, F.** *Paratrachymyrmex phaleratus*, D. Mera-Rodríguez. Photographs taken by W. Erichson and obtained from the Antweb database (http://www.antweb.org).

2017). Panama is known to be home for at least 54 fungus-growing ant species (Fernández and Sendoya 2004; Antweb 2020) and in the Brazilian state of Amazonas, 66 species of fungus-growing ants have been recorded (Fernández and Sendoya 2004; Guénard et al. 2017).

In Colombia, the highest richness of non-leaf-cutting fungus-growing ant species was found in the departments of Caquetá (Amazonian region), Antioquia (Central Andean mountains), and Chocó (Pacific coast), harboring 60% (n=24 species) of total attine species. The unequal species distribution observed across Colombian municipalities indicates a bias in sampling and/or curatorial efforts of researchers working in the two collections examined for this study. Our findings suggest that additional information of value regarding these ants in Colombia is likely to be found in other local collections, such as the Colección de Artrópodos Terrestres de la Amazonia Colombiana (CATAC) and the Instituto de Ciencias Naturales (ICN). Expanding both, sampling in the field and curation of museum holdings, is of paramount importance to gain a better understanding of insect diversity in Colombia.

Fungus-growing ants are a relatively small portion of the 1,166 ant species known in Colombia (Fernández and Serna 2019), but due to their significant economic impact, the leaf-cutting species have received much more attention from researchers than the other species (Vélez 1997; Chacón de Ulloa et al. 2006; Madrigal 2003; Della Lucia 2011; Della Lucia et al. 2014; Hölldobler and Wilson 2011; Montoya-Lerma et al. 2012; Fernández et al. 2015; Serna et al. 2019). The non-leaf-cutting attines remain mostly ignored and as a looming gap in our knowledge about the biology of the *Atta* genus-group. Future research needs to explore the richness, ecology,

and biology of the non-leaf-cutting fungus-growing ants.

We report several new distribution records for Colombia for species in the recently described genera *Mycetomoellerius* and *Paratrachymyrmex*. Based on a recent study by Solomon et al. (2019), the paraphyletic genus *Trachymyrmex* was divided into the three monophyletic genera *Mycetomoellerius*, *Paratrachymyrmex*, and *Trachymyrmex*. The genus *Trachymyrmex sensu stricto* contains nine described species, eight of which are restricted to northern Mexico and the southern United States and only a single species, *T. saussurei* (Forel, 1885), is known from Central America, ranging from Southern Mexico to Honduras (Rabeling et al. 2007; Sánchez-Peña et al. 2017). In contrast, species of *Mycetomoellerius* and *Paratrachymyrmex* are broadly distributed throughout Central and South America, and only a couple of *Mycetomoellerius* species, *M. turrifex* (Wheeler, 1903) and *M. jamaicensis*, occur in southern United States (Mayhé-Nunes and Brandão 2007; Rabeling et al. 2007; Solomon et al. 2019).

Our results corroborate that Colombia harbors a significant diversity of non-leaf-cutting fungus-growing ant species, but also notes that for most of them, their biology, behavior, and ecology remain to be explored. Our study emphasizes the importance of integrating field and museum research for biodiversity exploration in the Neotropics. We hope our results will serve as a reference and an incentive for systematically exploring the diversity of fungus-growing ants in Colombia.

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Authors Contributions

DMR, FS designed and conducted the study. DMR, FS, JSC and CR identified the specimens. DMR and JSC took photographs. DMR wrote the manuscript. FS, JSC, JL, and CR improved the manuscript and participated in the discussion. DMR made the figures.

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